Precision Cooling for
Business Critical Continuity

Liebert Xtreme Density™

System Design Manual

Liebert®

EMERSON™
Network Power

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1.0 SYSTEM DESCRIPTION

The Liebert XD™ family of cooling units delivers efficient, sensible cooling to high-heat environments. XD systems are designed to cool computer racks and hot zones in a data center or computer room without taking up expensive floor space for cooling components.

The Liebert XD family includes:

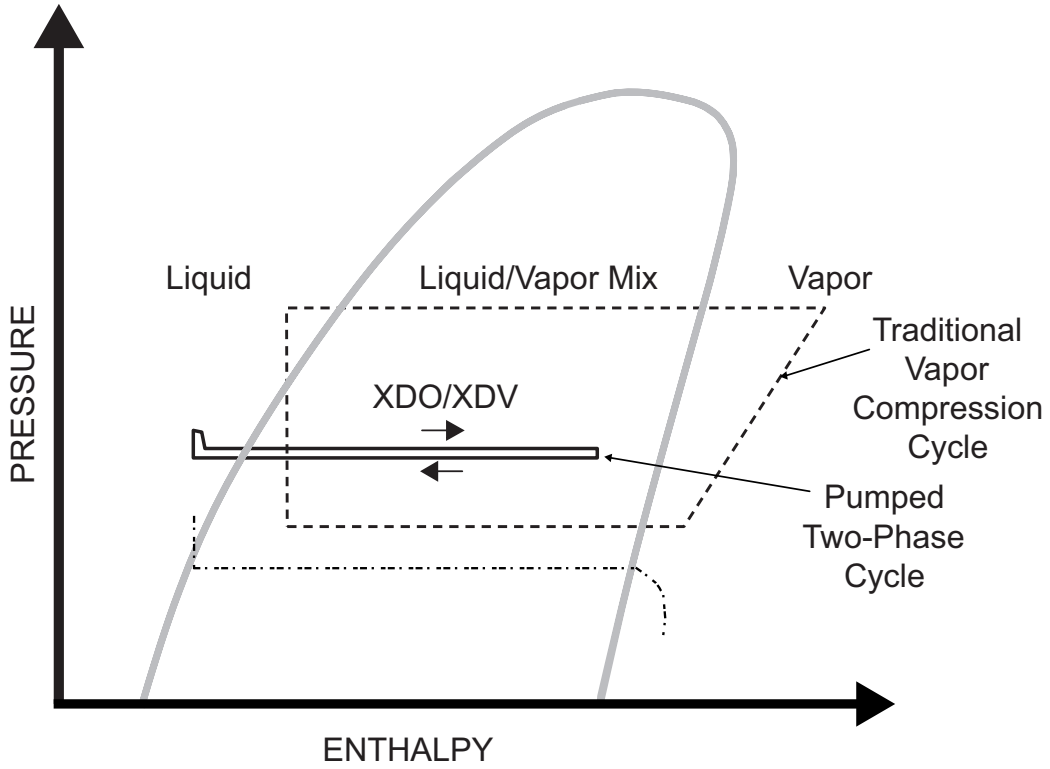
- **XDO**—XD Overhead unit, suspended from the roof structure
- **XDV**—XD Vertical unit, mounted on top of the equipment cabinet or suspended from the roof structure
- **XDP**—XD Pumping unit
- **XDC**—XD Chiller unit
- **XDA**—mounted on the front or rear of the equipment cabinet

Systems combining XDO, XDV units with XDP or XDC units can remove more than 16 kW of heat per cabinet.

The Liebert XD system also performs at high efficiency rates. Properly spaced cooling modules and the XD system's fluid phase change technology, combine to reduce an XD system's energy consumption to at least 18% less than a traditional cooling system.

The XD family maintains this energy efficiency by employing the heat absorption properties of a liquid (pumped refrigerant) through phased changes. Coolant is pumped as a liquid, becomes a gas within the heat exchangers of the cooling modules (either the XDO or XDV) and then is returned to either the XDP or XDC where it condenses to a liquid. This eliminates the compression cycle required by traditional systems. And, if a leak were to occur, the environmentally friendly coolant would escape as a gas, causing no harm to critical equipment (see **Figure 1**).Because no compressor is used in the circuit, no oil is needed.

Figure 1 Pressure enthalpy diagram - refrigerant



1.1 Direct and Indirect System Configurations

Liebert XD systems are available in **Direct** and **Indirect** configurations—differentiated essentially by the location of the pumping unit (see **Figures 2** and **3**). The indirect system uses a pumping unit to control and circulate the XD Coolant™. In the direct system, the pumping functions are incorporated in the chiller.

Figure 2 Direct system configuration—hydraulic system schematic

Direct XD System Configuration
Pumping and control are performed by chiller.

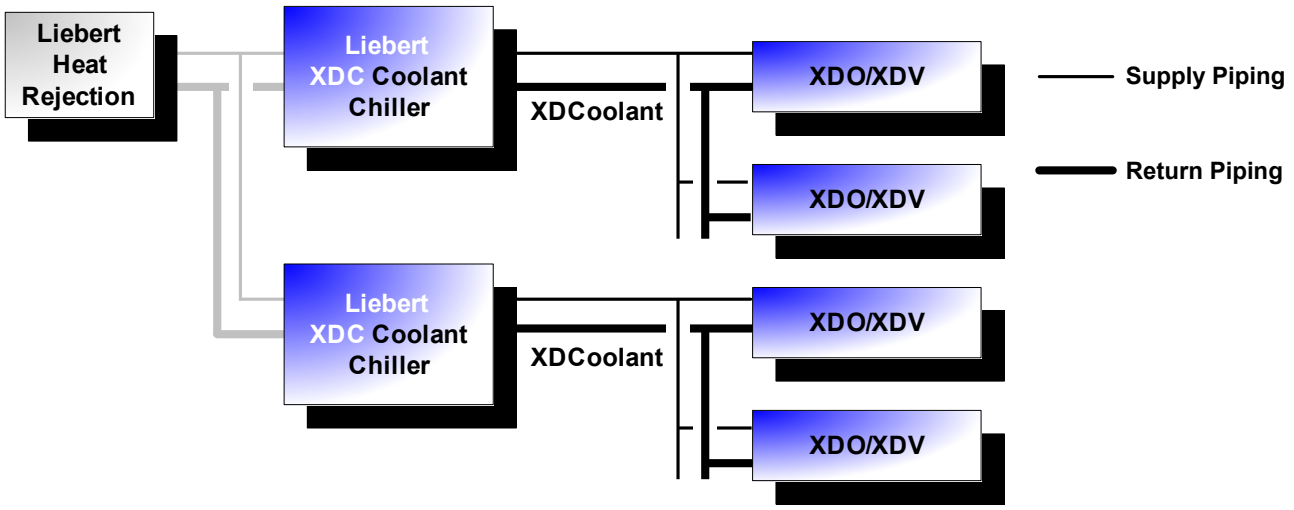
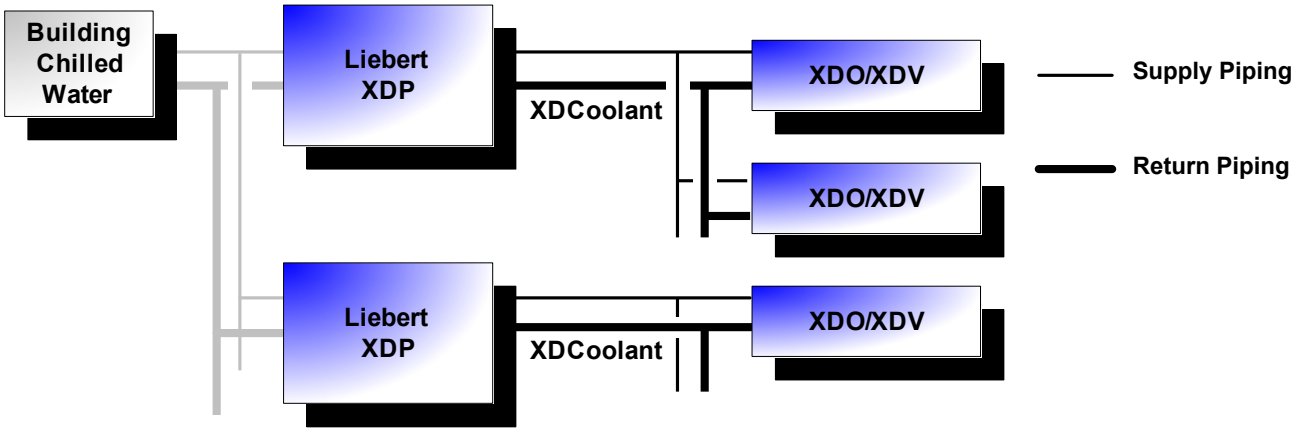


Figure 3 Indirect system configuration—hydraulic system schematic

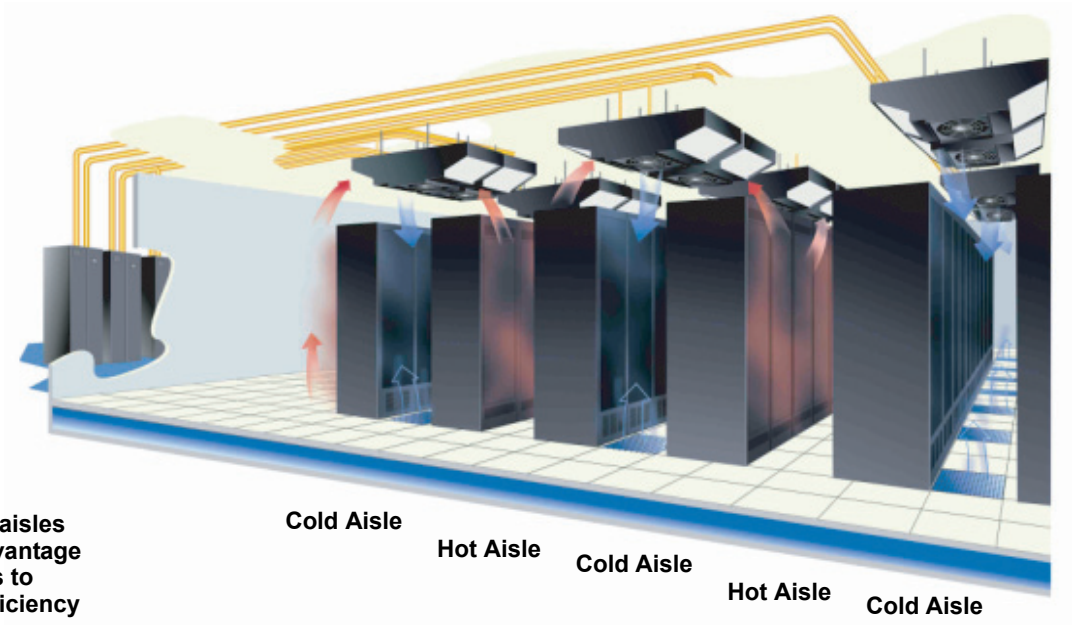
Indirect XD System Configuration
XDPs pump coolant to XDO and XDV modules, isolate coolant from building chilled water supply with an internal heat exchanger and maintains coolant above the dew point.



1.2 Liebert XDO—Overhead Cooling Module

The XDO ceiling-mounted cooling module draws in hot air rising from densely populated cabinets, passes it over the XDO's coils and exhausts cooled air downward into the cold aisle.

Figure 4 Suspended XDO modules in hot aisle-cold aisle arrangement


Hot aisles and cold aisles alternate, taking advantage of airflow properties to increase cooling efficiency
Cold Aisle
Hot Aisle
Cold Aisle
Hot Aisle
Cold Aisle

1.3 Liebert XDV—Vertical Above-Cabinet Cooling Module

The XDV is installed on top of or above a rack enclosure. It is available with optional flexible metal pipes with automatic shutoff at the ends for easy connection to the XD Coolant distribution pipes. This flexible piping is available pre-attached and pre-charged with refrigerant. The Liebert XDV may be set up in either of two ways:

- The XDV can take hot air directly from an equipment enclosure, cool the air and discharge it downward into the cold aisle.

  OR

- The XDV can draw hot air from the room, cool the air and discharge the cool air downward into the cold aisle.

Figure 5 Top-mounted XDV modules with fixed piping in hot aisle-cold aisle arrangement

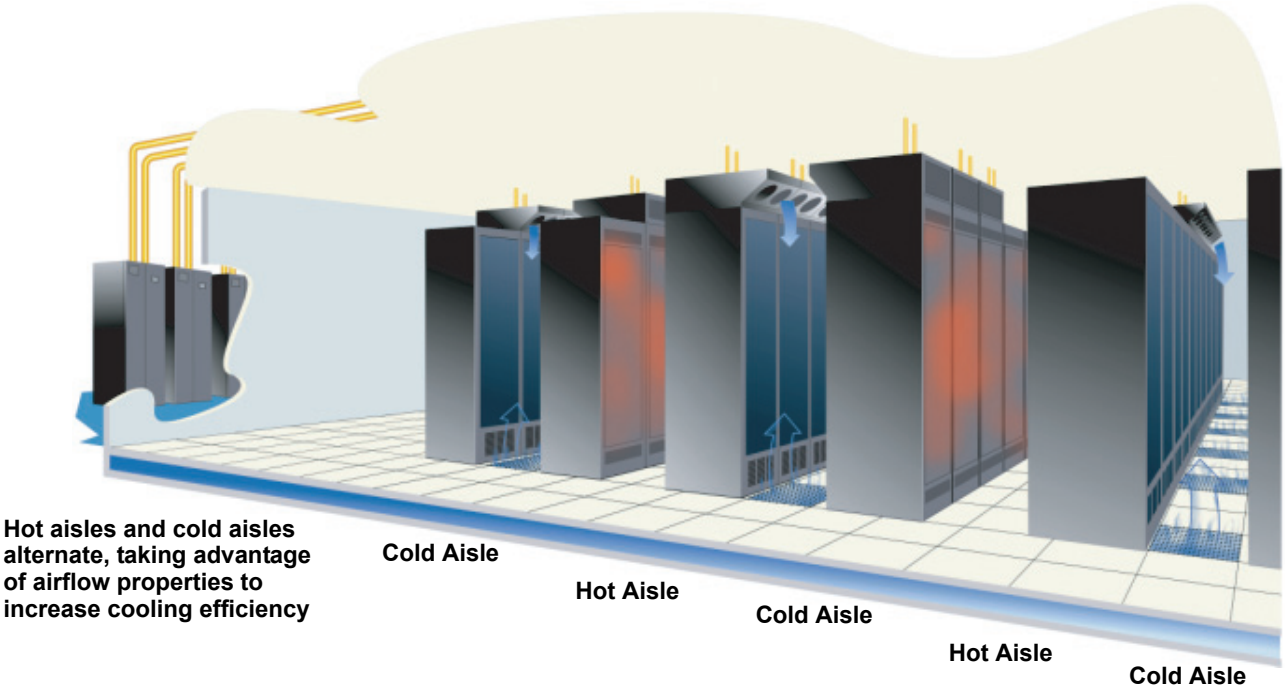
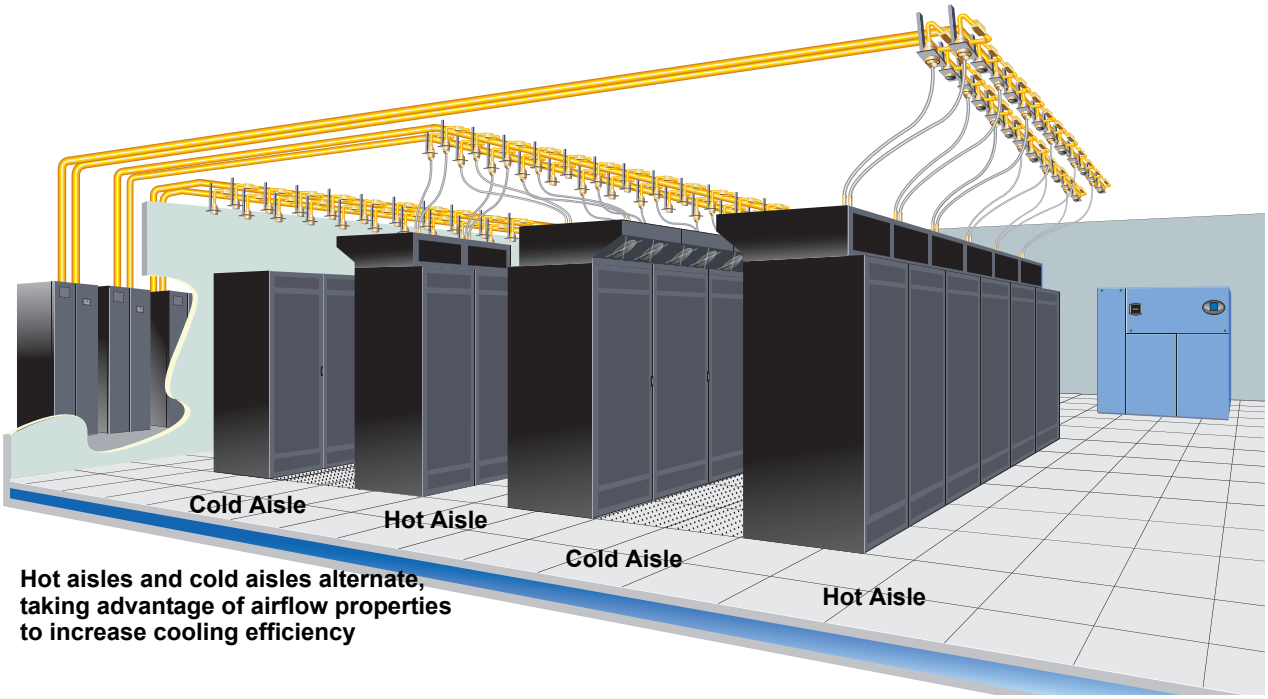

Hot aisles and cold aisles alternate, taking advantage of airflow properties to increase cooling efficiency
Cold Aisle
Hot Aisle
Cold Aisle
Hot Aisle
Cold Aisle

Figure 6 Top-mounted XDV modules with flexible piping in hot aisle-cold aisle arrangement


Cold Aisle
Hot Aisle
Cold Aisle
Hot Aisle
Hot aisles and cold aisles alternate, taking advantage of airflow properties to increase cooling efficiency

1.4 Liebert XDP—Pumping Unit

The XDP isolates the building's chilled water circuit from the XD Coolant circuit. The XDP circulates coolant to XDV or XDO modules while preventing condensation by maintaining the coolant's temperature above the dew point.The XDP employs two sets of remote sensors to determine the temperature and humidity in the air and instantly adjusts coolant supply temperature to compensate for changing conditions.

Figure 7 XDP pumping unit

1.5 Liebert XDC—Chiller

The XDC is an indoor chiller that connects directly to the XDO or XDV units and provides coolant circulation and control. The XDC keeps the XD Coolant temperature above the dew point and eliminates the need for a separate pumping unit in the direct system configuration. The XDC employs two sets of remote sensors to determine the temperature and humidity in the air and instantly adjusts coolant supply temperature to compensate for changing conditions.

Figure 8 XD Chiller unit

1.6 Liebert XD Piping

Liebert XD Piping is prefabricated distribution piping that is installed in anticipation of a growing system. XDV cooling modules are added as required and are quickly made operational with flexible connection piping with threaded couplings. This unique system allows the room cooling capacity to increase to more than 500 Watt per square foot (5400 W/m2) with no additional disruptive piping installation. The flexible connection piping also allows the cooling modules to be re-positioned without interruption in operation.

Liebert XD Field Piping Kits

Field piping kits are available in two versions

- 10 ft. (3.05m) with five ports for connecting five XDV modules
- 8 ft. (2.44m) with two ports for connecting two XDV modules

  Each version is available in two pipe sizes:
  - Supply pipe: 1-1/8"; return pipe: 2-1/8"
  - Supply pipe: 1-3/8"; return pipe: 2-5/8"

Each kit contains supply pipe(s) and return pipe(s). Each port has a threaded coupling at the end with automatic shutoff when disconnected. Each port also has a ball valve for manual shutoff.

XD Connection Port Kit

The connection ports in the XD Field Piping Kits are available as XD Connection Port Kit. Each port has a threaded coupling, with automatic shutoff when disconnected, at the end. Each port also has a ball valve for manual shutoff. Each kit contains one supply and one return port. Two kit sizes are available:

- Supply pipe: 1-1/8"; return pipe: 2-1/8"
- Supply pipe:1-3/8"; return pipe: 2-5/8"

1.7 Liebert XDA—Air Flow Enhancer

The XDA is a fan unit that boosts the airflow through densely populated enclosures, removing hot spots from within the racks. One or two units can be mounted on most rack enclosures.

Figure 9 XDA—air flow enhancer—on Liebert Foundation enclosure

2.0 STARTING A NEW EQUIPMENT COOLING PROJECT

2.1 Determining Cooling Equipment Needs

1. Is there adequate space available for an XD installation?
2. Is the hot aisle/cold aisle approach being utilized for this room design or can it be utilized in this room design?
3. Is redundant cooling equipment required?
4. Are there access considerations for all components (possible rigging problems)
5. What heat load growth is anticipated over the next few years?
6. How are the cabinets going to be populated (density of heat generation)?
7. What monitoring requirements are desired or needed?
8. Who will be involved in this project (stakeholders)?
9. Is there existing computer room environmental cooling systems for humidity control and filtration?
10. Is the vapor barrier sufficient?
11. Is a chilled water system available?
    a. What is the system's capacity?
    b. What is the system's chilled water supply temperature?
    c. Does the chilled water supply temperature vary during the year or is the temperature constant?
12. How much power is available for cooling equipment?
13. What is the maximum distance between the XDP/XDC unit and the farthest XDO/XDV units in the proposed layout?
14. If an air cooled XDC is used – is an area available for the remote condenser? ?

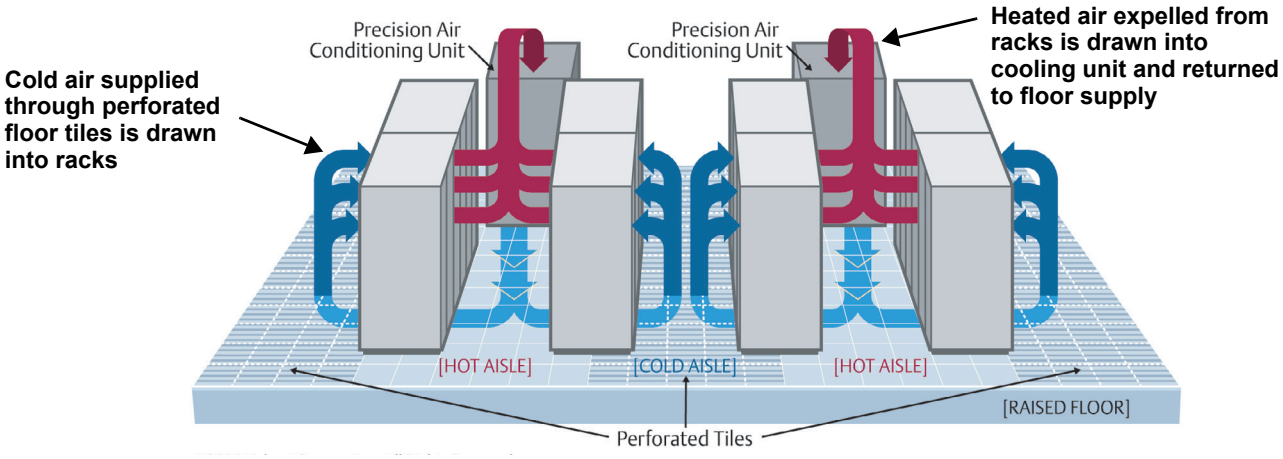
2.2 Implementing a Hot-Aisle/Cold Aisle Design

A best practice is to use rows of equipment racks in an alternating arrangement of "cold aisles" and "hot aisles." This is best accomplished when the layout of the file-server farm area is first being planned. and it is exceedingly more difficult to accomplish when the computer room is already populated with operating hardware.

A cold aisle is defined as having perforated floor tiles that allow cooling air to come up from the plenum under the raised floor, and a hot aisle has no perforated tiles. In the cold aisle, the equipment racks are arranged face to face so the cooling air discharged up through the perforated floor tiles is sucked into the face of the computer hardware and exhausted out the back of the equipment rack onto the adjacent hot aisles.

Hot aisles are literally hot because the objective of the alternating cold and hot aisle design is to separate the source of cooling air from hot air discharge which returns to the computer-room cooling unit. Therefore, no perforated tiles should be placed in the hot aisles. as this would mix hot and cold air and thereby lower the temperature of the air returning to the cooling units, which reduces their usable capacity.

Figure 10 Hot aisle-cold aisle arrangement with under-floor source


Precision Air Conditioning Unit
Precision Air Conditioning Unit
Heated air expelled from racks is drawn into cooling unit and returned to floor supply
Cold air supplied through perforated floor tiles is drawn into racks
[HOT AISLE]
[COLD AISLE]
[HOT AISLE]
[RAISED FLOOR]
Perforated Tiles

3.0 DESIGNING A LIEBERT XD SOLUTION

Liebert XD systems are intended for use with precision air conditioning equipment, such as the Liebert Deluxe System/3 and Liebert DS. The precision air conditioning equipment is required to control the room's humidity and to filter the air.

The XD systems provide efficient, highly effective heat removal (sensible cooling only), and provide no dehumidification. The XD control system maintains the coolant temperatures just above the dew point of the space to prevent condensation. Since the capacity of the system is limited by the dew point in the space, sufficient dehumidification and an adequate vapor barrier must be provided to maintain the dew point at or below the level necessary to achieve the required capacity.

In their maximum density configurations, the XDO/XDV system can provide more than 16kW of cooling capacity per rack.

The Liebert XD system is optimized for hot aisle/cold aisle equipment configurations, the industry's most highly recommended method for dealing with extremely high heat loads.

Refer to the technical data manual of either the Deluxe System/3 (SL-18100) or the Liebert DS (SL-18810) for additional installation and application guidelines that apply to all critical space cooling applications.

3.1 Determine Cooling Requirements and Select Liebert XD System

1. Calculate the total cooling required
2. Determine placement of the XD units
3. Determine required pipe sizes
4. Calculate the coolant volume of the XD systems
5. Complete design details including, electrical, mounting, piping, etc.

3.2 Calculate the Heat Load to be Handled by Liebert XD System

When designing a cooling solution using the XD system, the initial steps are similar to those required to cool a conventional critical space. The total heat load must be calculated, including sensible and latent cooling requirements. These should be increased by the reserve capacity needed for pull-down situations where the room temperature must be reduced and to provide for unexpected increases in heat load.

NOTE
Reserve capacity is distinct from redundant capacity in that redundant capacity may or may not be available concurrently with normal operating capacity. Reserve capacity is available concurrently with normal operating capacity.

The next step is to determine how much of the required cooling capacity is to be provided by Liebert Deluxe or Liebert DS units. If the facility is new, typically up to 150 watts per square foot (1500 watts per m^2) of cooling can be obtained from Liebert precision air conditioning units supplying air through a raised floor. In existing facilities, such factors as raised floor height, under-floor obstructions or other limitations may reduce this to less than 50 watts per square foot (500 watts per m^2).

Once the total required sensible cooling capacity is known, subtract the sensible cooling portion to be provided by Liebert Deluxe or Liebert DS units. This yields the cooling capacity to be provided by the XD system.

3.3 Selecting Liebert XDO or Liebert XDV Modules

The next step is to select XDO or XDV cooling modules to be configured into the solution. An XDO and an XDV can be connected to the same XDP/XDC piping circuit.

Generally, the XDO is selected for use in new installations or renovations where the unit can be installed on the ceiling or in the overhead space.

The XDV is designed to permit mounting directly on top of an equipment cabinet, for ease of installation in existing facilities. The XDV may also be suspended from overhead, using suitable mounting methods.

3.4 Airflow Requirements for Liebert XD Solutions

Computer manufacturers typically specify a temperature change from intake to exhaust (delta T) of 18-27°F (10-15°C) for the air passing through a rack enclosure. The heat generated by electronic equipment combined with the tight quarters of equipment cabinets mean that high volumes of air must move through an enclosure to meet this cooling specification.

An XD system can supply the cooled air to satisfy this cooling demand, but airflow through the enclosure must be adequate to extract the heat from the cabinet. Liebert's XDA units can boost the airflow to levels necessary to protect critical equipment. It is particularly suited to the hot aisle/cold aisle arrangement.

3.5 Liebert XDO Placement

3.5.1 Determining Spacing of XDOs in an Aisle

XDO units should be placed in rows directly above the cold aisles of a room for optimum cooling. Each XDO serves an area equal in width to the cold aisle spacing (typically 12 to 16 feet [3.7 to 4.9m]). The length of the area served includes any space between XDO modules in a row. Depending on the cooling capacity to be achieved, spacing between XDO modules in a row can vary from zero to as much as 6 feet (1.8m). When the spacing increases to more than 6 feet (1.8m), overall performance of the system may be negatively affected and gaps in cooling may occur.

Liebert recommends installing one XDO at the end of each aisle being cooled and to space the remainder between these "end units" in pairs as shown in **Figure 12**. This layout will block the incursion of hot air around the side of the end cabinets.

Figure 11 XDO placement over cold aisle

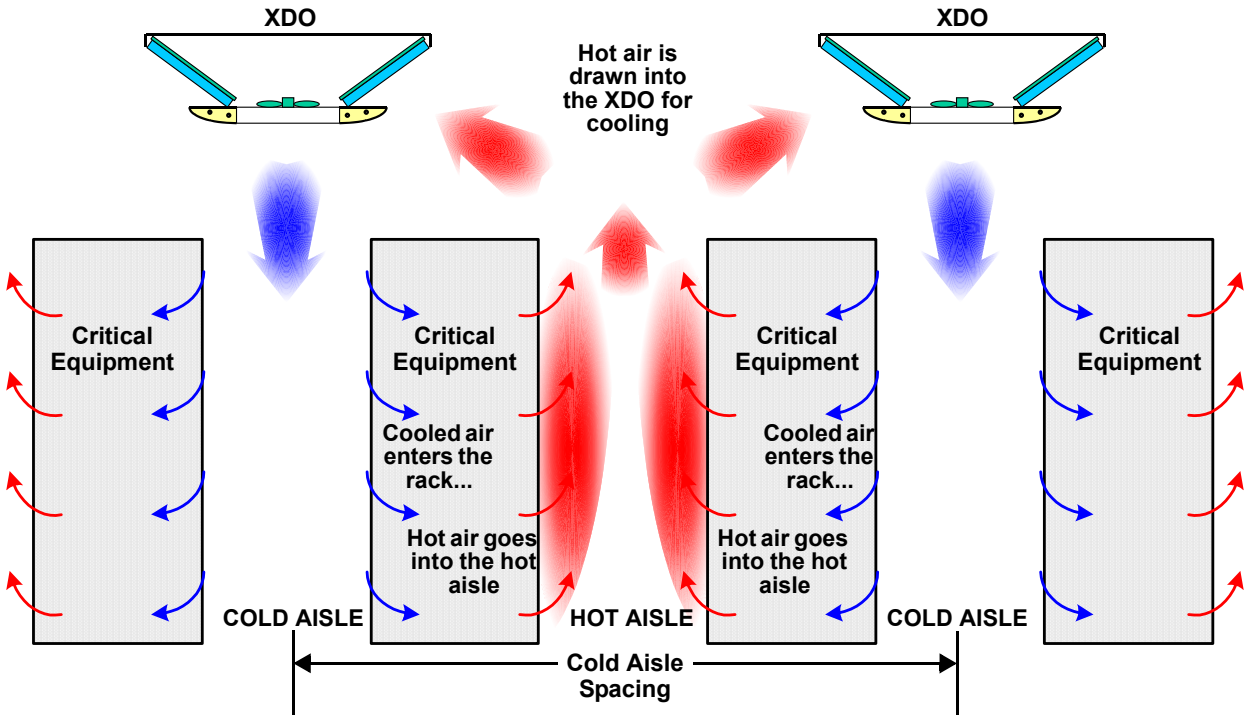


Table 1 can be used to determine the correct number and spacing of XDOs.

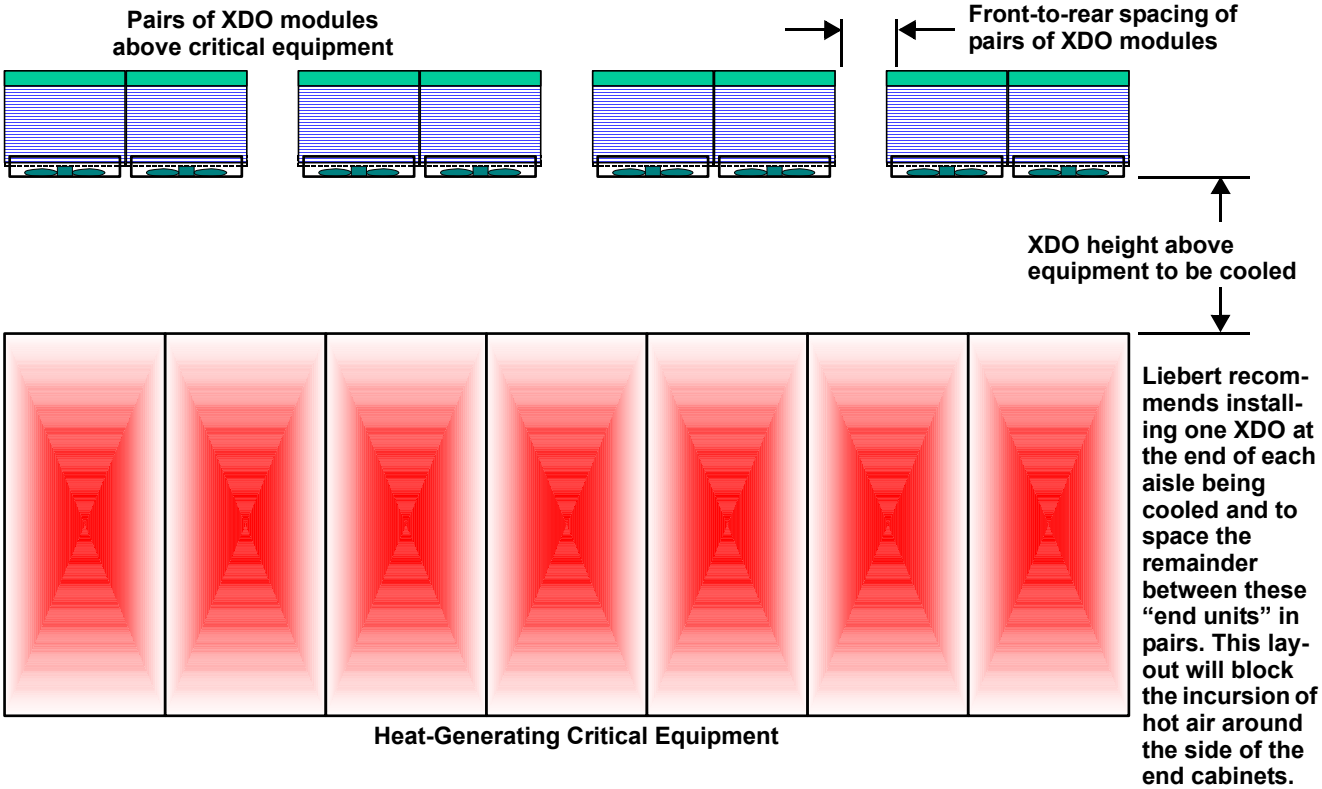
Table 1 Calculating quantity and spacing of XDO modules

Input Information	Step	Result
Total heat load in the room, kW	A	
Reserve capacity needed (10% to 25% of A is recommended)	B	
	C	Required cooling capacity = A + B
Existing/planned Liebert Deluxe/DS unit sensible capacity	D	
	E	Required XD system cooling capacity = C – D
	F	Number of XDOs required = E ÷ 16, rounded up (60Hz) =E ÷ 14, rounded up (50Hz)
	G	Number of XDP/XDC modules required = F ÷ 10, rounded up (60Hz and 50Hz)
Room area, square feet	H	
	I	Area served by each XDO = H ÷ F
Spacing of cold aisles, center-to-center, typically 12-16 ft (3.7 to 4.9m)	J	
	K	Spacing between each XDO = (I ÷ J) - 2
	L	Required XD system cooling density = E ÷ H OK if under 640; otherwise, additional cooling is required from Liebert Deluxe or Liebert DS units.

3.5.2 Determining Vertical Placement of Liebert XDOs Above the Cold Aisle

In the maximum density configuration, Liebert recomments placing the XDOs between 18 and 24 inches (457-609mm) above the equipment cabinets. In some cases where the required density is less, the front-to-rear spacing of XDOs in a row will be increased. To ensure coverage of the wider spaces between the XDO units, the vertical distance between the cabinets and the XDOs should be increased. However, the recommended maximum height of the XDO above the cabinets is 30 inches (762mm). See **Figures 12**.

Figure 12 XDO spacing—horizontal and vertical

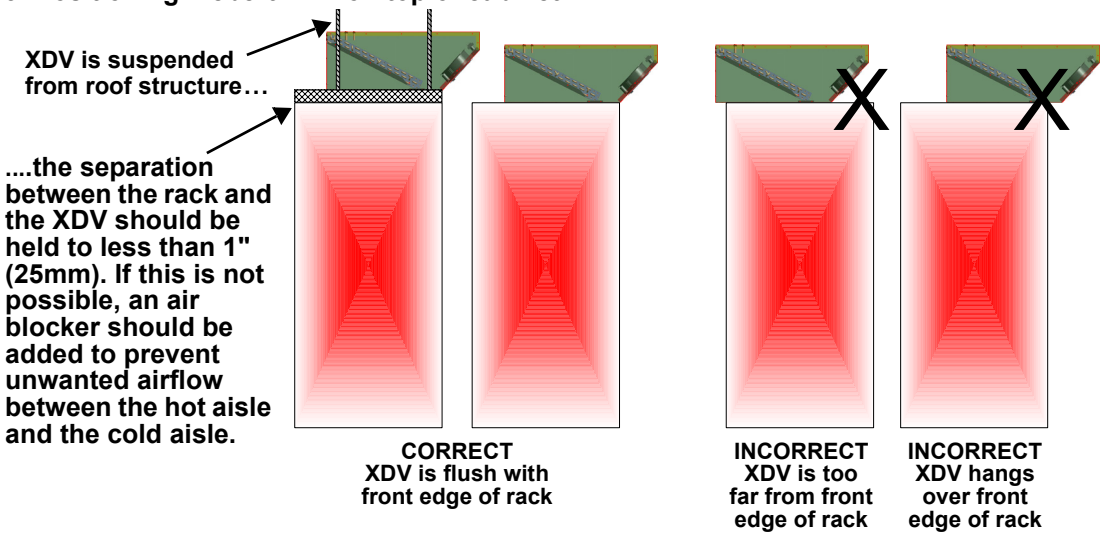

Pairs of XDO modules above critical equipment
Front-to-rear spacing of pairs of XDO modules
XDO height above equipment to be cooled
Heat-Generating Critical Equipment
Liebert recommends installing one XDO at the end of each aisle being cooled and to space the remainder between these “end units” in pairs. This layout will block the incursion of hot air around the side of the end cabinets.

3.6 Liebert XDV Unit Placement

XDV units should be placed on top of the cabinets that generate the greatest amount of heat. If heat loads are dispersed evenly throughout the room, the XDV modules may be spread out accordingly.

The XDV must be placed toward the front of the equipment cabinet, so that its front bottom edge is flush with the front top edge of the cabinet. Placing the unit farther back on the top of the unit will restrict airflow into the cold aisle. Placing the unit farther to the front will decrease the amount of hot air drawn into the unit.

Figure 13 Positioning Liebert XDV on top of cabinet


XDV is suspended from roof structure…
....the separation between the rack and the XDV should be held to less than 1" (25mm). If this is not possible, an air blocker should be added to prevent unwanted airflow between the hot aisle and the cold aisle.
CORRECT
XDV is flush with front edge of rack
INCORRECT
XDV is too far from front edge of rack
INCORRECT
XDV hangs over front edge of rack

Both of the XDV's power cords should be connected to power sources. If only one power source is available, then only the power cord labeled "SECONDARY" should be connected to the power source.

Piping for the XDV is routed upward to the main return and supply pipes to and from the XDP/XDC.

Table 2 below can be used to determine the correct number of XDV modules.

Table 2 Determine required number of XDV modules

Input Information	Step	Results
Total heat load in the room, kW	A	
Reserve capacity needed (10% to 25% of A is recommended)	B	
	C	Required cooling capacity = A + B
Existing/planned Liebert Deluxe/DS sensible capacity	D	
	E	Required XD system cooling capacity = C – D
	F	Number of XDV modules required = E ÷ 8, rounded up (60Hz) = E ÷ 6.5, rounded up (50Hz)
	G	Number of XDP/XDC modules required = F ÷ 20, rounded up (60Hz) = F ÷ 21.5, rounded up (50Hz)
Room area, square feet	H	
	I	Area served by each XDV = H ÷ F
	L	Required XD system cooling density = E ÷ H OK if under 580 for 12-foot cold aisle spacing OK if under 435 for 16-foot cold aisle spacing Otherwise, additional Liebert Deluxe or Liebert DS unit capacity is needed.

3.7 Liebert XDP/XDC Placement

The XDP/XDC may be placed in the critical space or in an adjacent equipment room. The allowable distance between the XDP/XDC and its connected cooling modules is determined by the piping design and by the amount of coolant required. Refer to **3.9 - Liebert XD Coolant™** and **3.10 - Liebert XD Piping System Design**.

The maximum height of any of the main or connecting piping should be no more than 20 feet (6m) above the top of the XDP/XDC unit. XD cooling modules should be placed as close to the same level as possible. The differences in elevation between the highest and lowest cooling module in a system should be no more than 6 feet (2m).

3.8 Examples of Expansion and Interlaced Connection of Liebert XD Cooling Modules

Figure 14 XDV units mounted on racks emitting 3kW of heat top view

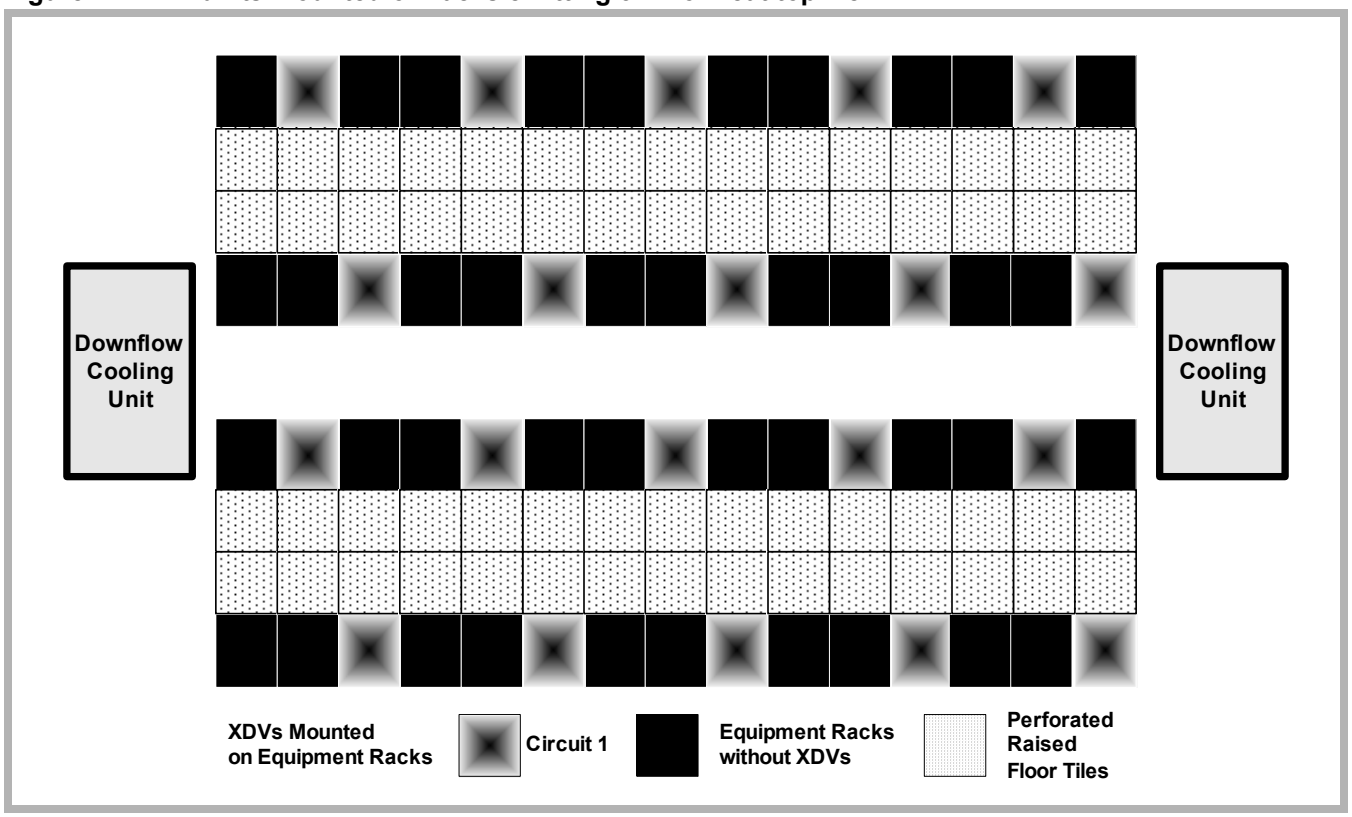


Figure 15 XDV units mounted on racks emitting 5kW of heat top view

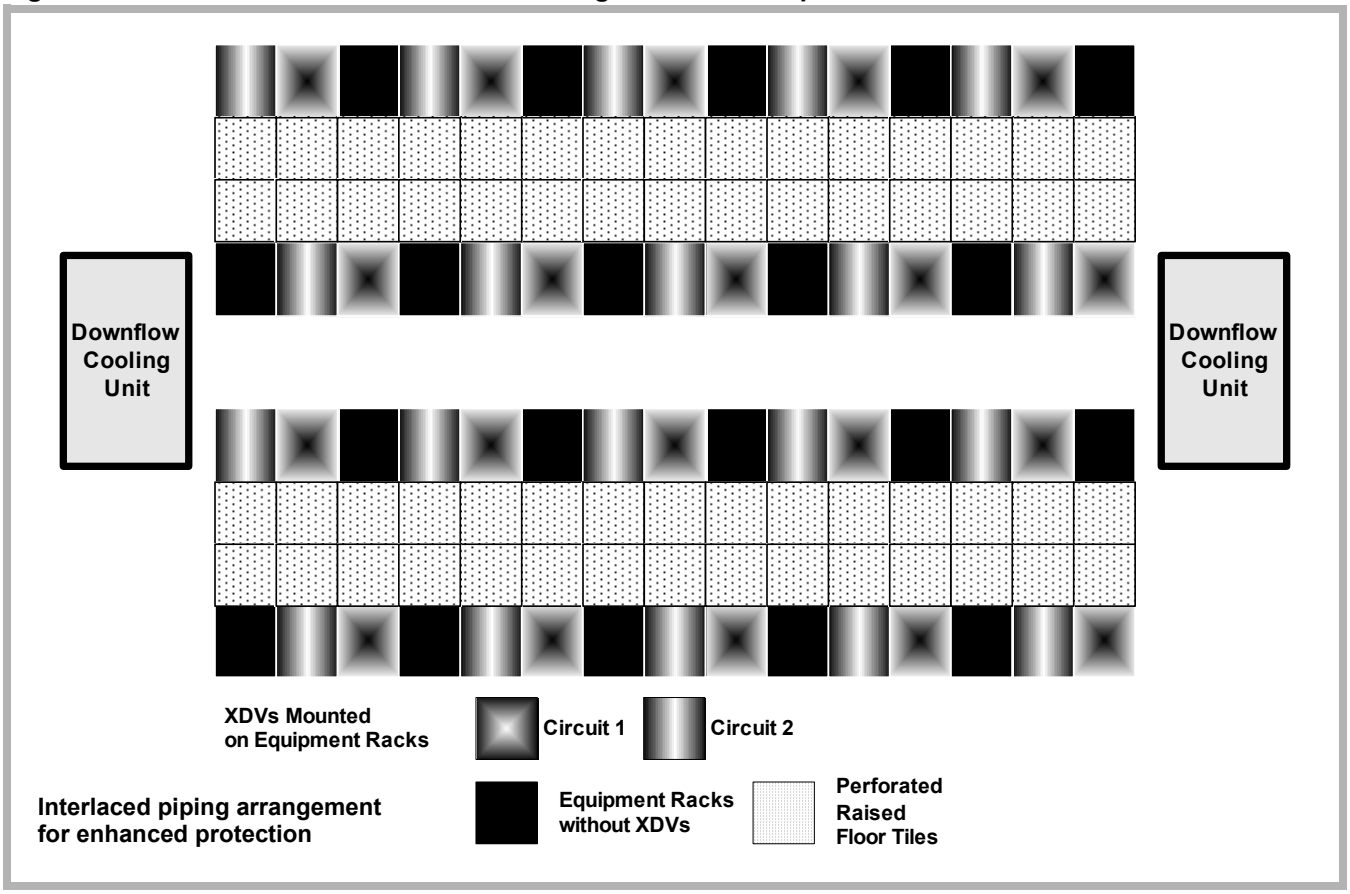


Figure 16 XDV units mounted on racks emitting 8kW of heat top view

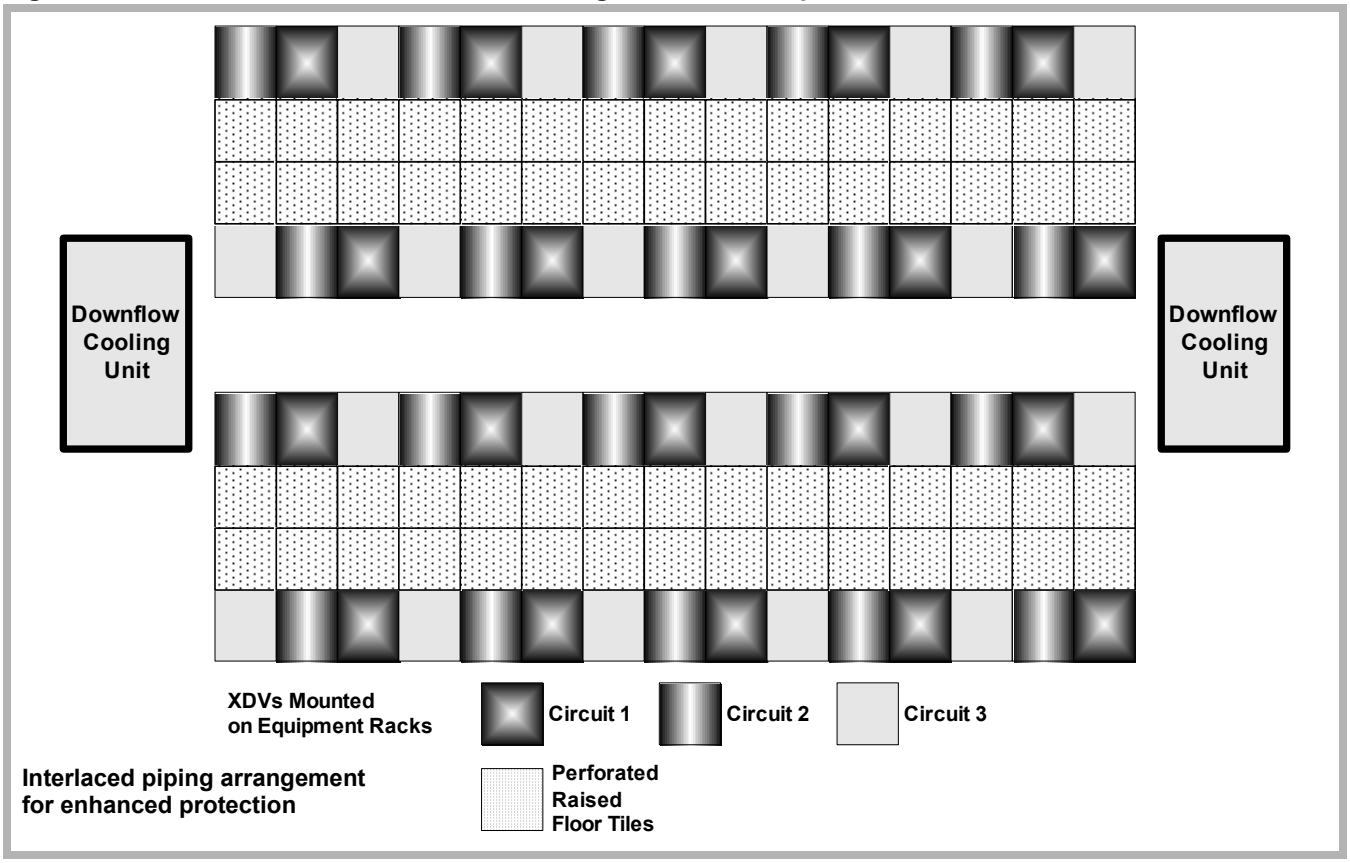
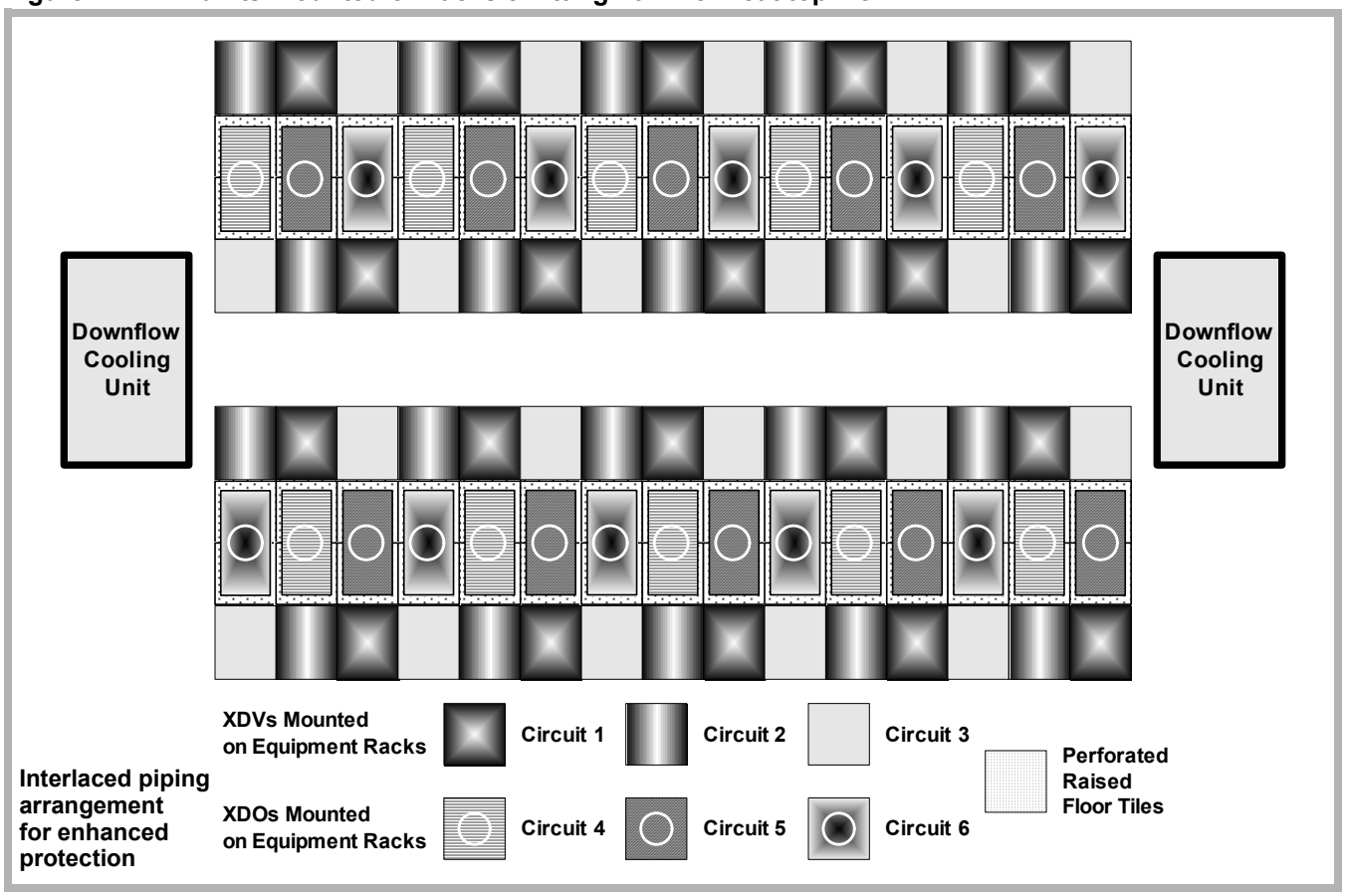


Figure 17 XDV units mounted on racks emitting 16kW of heat top view



3.9 Liebert XD Coolant™

The coolant used in the XD system is HFC-134a (1,1,1,2-tetrafluoroethane), made by a number of manufacturers. The amount of coolant used by the XD system may be significantly higher than typical DX cooling systems.

CAUTION

The XD pumped R-134a refrigerant circuits do not use refrigerant oil.

Do NOT put oil in the R-134a system.

All the major components of an XD system must be installed in a space with a volume of at least 1,000 ft^3 (28.3m^3) for each 16 pounds of coolant in that system from *Table 1, ASHRAE Standard 15-2001, Safety Standard for Refrigeration Systems*. If the XDP/XDC is placed in a separate area, such as a machine room, then this area must also meet the volume requirement. Inside the critical space, this includes the space under the raised floor, and the space between the top of the raised floor and the bottom of a suspended ceiling. If the suspended ceiling is all open grates, then this additional space, up to the overhead deck, would also be included.

Example

A space is 5,000 square feet, with an 18" raised floor and an 8' 6" suspended ceiling. XDOs and an XDP are to be placed in this raised floor area.

The volume of the space is (1.5 + 8.5) x 5,000 or 50,000 cubic feet.

The maximum amount of R-134a coolant that can be used in a single XDP/XDC/XDO/XDV system within this space is **16 * (50000/1000) = 16 * 50 = 800 lb**.

Multiple XD systems can be installed in this space, as long as the amount of R-134a coolant in any one system does not exceed 800 lb.

NOTE

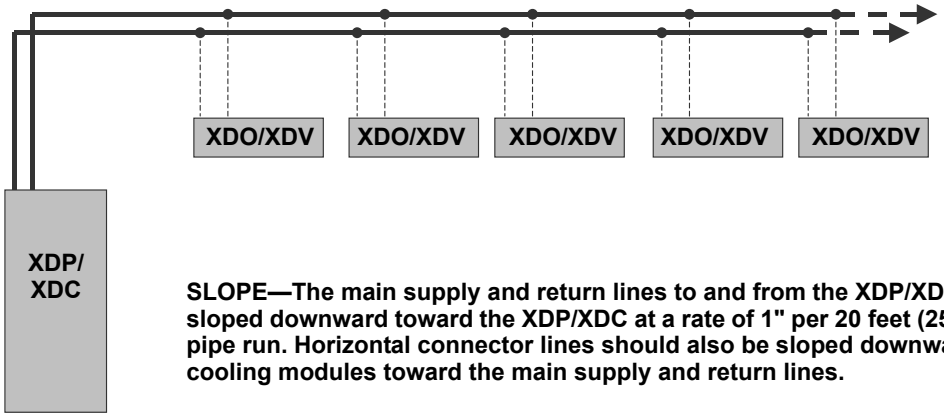
Local codes might permit exceeding the maximum refrigerant limit stated above if refrigerant detector and an exhaust system are installed. As an alternative, oxygen sensors may be installed to meet some local codes.

3.10 Liebert XD Piping System Design

All piping must be ASTM (American Society for Testing and Materials) Type L copper pipe. The typical maximum operating pressure in the system is 90 psi (620kPa).

Piping for the XD system is arranged in a manner similar to piping for a chilled water system. XDOs or XDVs are connected in parallel between main return and supply pipes going to and from the XDP/XDC. **Figure 18** represents a typical configuration. **The guidelines provided for pipe size must be strictly followed. Failure to size the main lines and connection lines adequately may result in reduced cooling capacity.** The critical aspects of pipe sizing are related to coolant volume and pressure drop. Both must be minimized.

Figure 18 Piping for XDP/XDC used with XDO or XDV units


XDO/XDV
XDO/XDV
XDO/XDV
XDO/XDV
XDO/XDV
XDP/
XDC
SLOPE—The main supply and return lines to and from the XDP/XDC must be sloped downward toward the XDP/XDC at a rate of 1" per 20 feet (25mm per 6m) of pipe run. Horizontal connector lines should also be sloped downward from the cooling modules toward the main supply and return lines.

The assembly and connection means used for piping in the XD system are similar to that of conventional refrigeration systems. Brazing material or soft solder may be used. However, if brazing material is used, the lines being brazed MUST be pressurized with flowing dry nitrogen during brazing to prevent excessive oxidation and scale formation inside the piping.

Please see **Table 3** below for recommended pipe sizes and **Figure 19** for piping segment locations.

Table 3 Supply, return pipe sizes—equivalent lengths

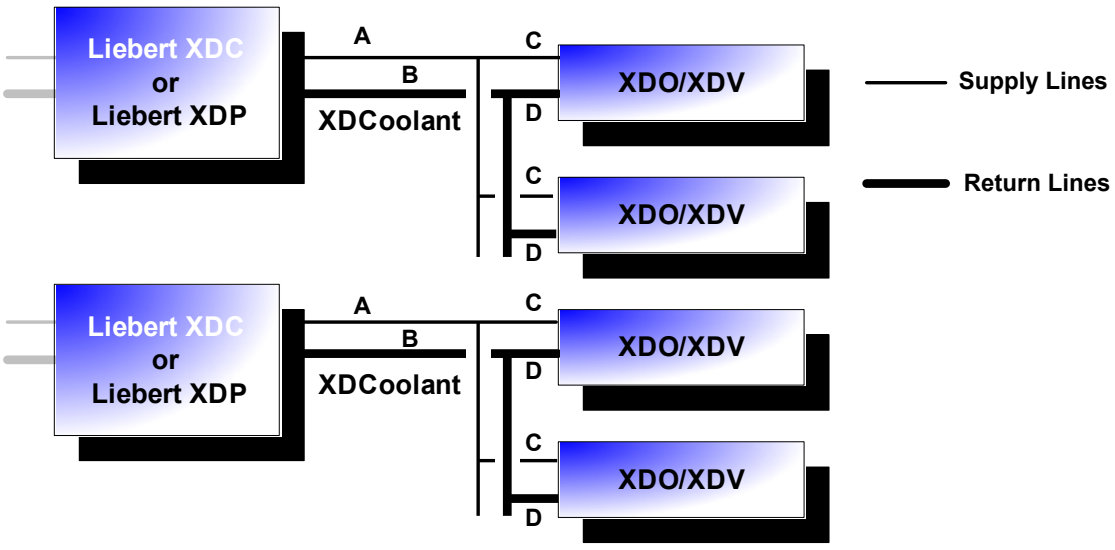
Pipe Function	Key to Piping in Figure 19 Schematic	Size / Pipe Run (Equivalent Lengths)
XDP/XDC supply line, from XDP/XDC supply to farthest XDO or XDV	A	1-1/8" OD for lengths up to 60 feet (18m)
		1-3/8" OD for lengths over 60 but less than 175 feet (18-53m)
XDP/XDC return line, from XDP/XDC return to farthest XDO or XDV	B	2-1/8" OD for lengths up to 60 feet (18m)
		2-5/8" OD for lengths over 60 but less than 175 feet (18-53m)
From XDO supply to supply line of XDP/XDC	C	1/2" OD for lengths up to 10 feet (3m)
		7/8" OD for lengths over 10 but less than 25 feet (3-7.6m)
From XDO return to return line of XDP/XDC	D	7/8" OD for lengths up to 10 feet (3m)
		1-1/8" OD for lengths over 10 but less than 25 feet (3-7.6m)
From XDV supply to supply line of XDP/XDC	C	1/2" OD for lengths up to 6 feet (1.8m)
		5/8" OD for lengths over 6 but less than 35 feet (1.8-10.6m)
From XDV return to return line of XDP/XDC	D	5/8" OD for lengths up to 6 feet (1.8m)
		7/8" OD for lengths over 6 but less than 35 feet (1.8-10.6m)

For additional information about piping connections, see the unit's user manual: XDP, 16641; XDC, SL-16671; XDO, SL-16661; and XDV, SL-16621.

CAUTION

To minimize the amount of XD Coolant required, do NOT oversize the piping.

Figure 19 Hydraulic schematic



3.11 Liebert XD Piping Slope

The main supply and return lines to and from the XDP/XDC must be sloped downward toward the XDP/XDC at a rate of 1" per 20 feet (25mm per 6m) of pipe run. Horizontal connector lines should also be sloped downward from the cooling modules toward the main supply and return lines.

3.12 Bypass Flow Controllers

To ensure the XDP/XDC pumps operate within the optimum range, some installations require one or more bypass flow controller(s). These devices are added to the field piping, and simulate the flow of additional cooling modules.

Each bypass flow controller should be installed with one shutoff valve to allow the controller to be disabled when cooling modules are added to an XD system.

Bypass flow controllers may be placed anywhere in the field piping but should be placed in a convenient, accessible location. See **Figures 20** and **21** for piping details of the bypass flow controller.

Refer to **Table 4** to determine the number of bypass flow controllers needed, based on the total nominal cooling capacity of the cooling modules in each XD system.

Table 4 Bypass flow controllers required in a Liebert XD system

	Number of Bypass Flow Controllers	
	In XDP System	In XDC System
XDV Units		
16-20	0	0
12-15	1	1
8-11	2	2
4-7	3	Not Recommended
XDO Units		
8-10	0	0
6-7	1	1
4-5	2	2
2-3	3	Not Recommended

Figure 20 Bypass flow controller arrangement

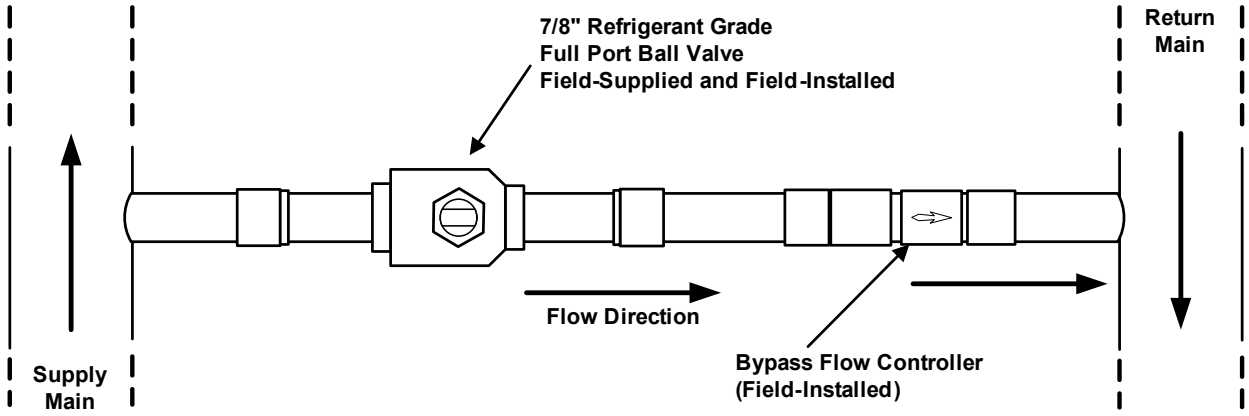
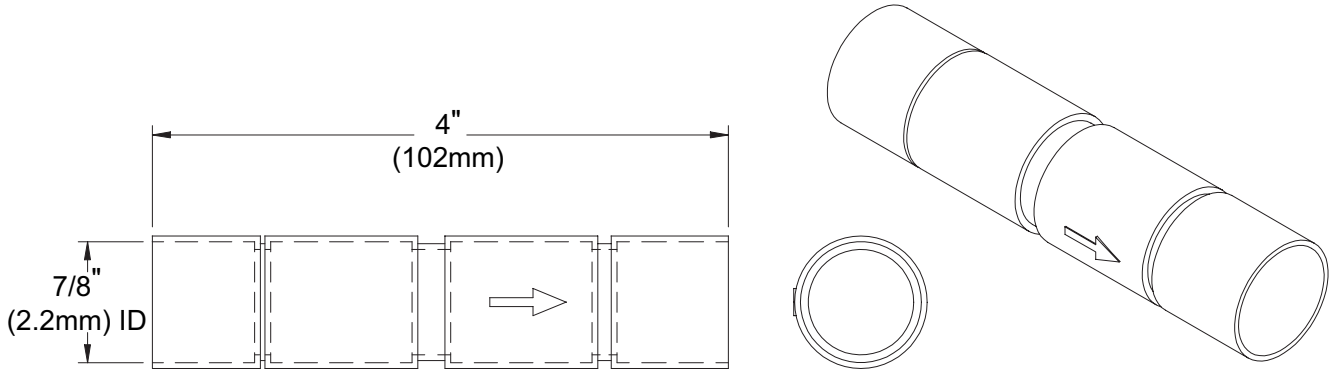


Figure 21 Bypass flow controller details, dimensions



3.13 Determining Coolant Volume

After the preliminary system design is completed, **Tables 5**, through **9** may be used to determine the amount of coolant required. Perform the calculation below for each XD system being configured.

NOTE
All lengths in the tables below—**Tables 5** and **6** —*are actual pipe lengths, not equivalent pipe lengths*

3.13.1 Liebert XDP/XDC Pumped R-134a Circuit Volume

Table 5 Coolant volume calculations – XDP/XDC with XDV systems

145 lb. R-134a per XDP (includes charge of one XDP while running)	
+1.46	lb. R-134a per XDV (does not include piping connector lines to and from XDV)
0.45	lb. per foot (305mm) of main supply actual length per 1-1/8" OD copper tubing
0.68	lb. per foot (305mm) of main supply actual length per 1-3/8" OD copper tubing
0.28	lb. per foot (305mm) of main return actual length per 2-1/8" OD copper tubing
0.43	lb. per foot (305mm) of main return actual length per 2-5/8" OD copper tubing
0.08	lb. per foot (305mm) of 1/2" OD copper tubing XDV supply connector actual length
0.13	lb. per foot (305mm) of 5/8" OD copper tubing XDV supply connector actual length
0.02	lb. per foot (305mm) of 5/8" OD copper tubing XDV return connector actual length
0.04	lb. per foot (305mm) of 7/8" OD copper tubing XDV return connector actual length
=	Amount of XD Coolant needed for ONE XDV/XDP system

Table 6 Coolant volume calculation – XDP/XDC with XDO systems

145 lb. R-134a per XDP (includes charge of one XDP while running)	
+2.92	lb. R-134a per XDO (does not include piping connector lines to and from XDO)
0.45	lb. per foot of main supply actual length per 1-1/8" OD copper tubing
0.68	lb. per foot of main supply actual length per 1-3/8" OD copper tubing
0.28	lb. per foot of main return actual length per 2-1/8" OD copper tubing
0.43	lb. per foot of main return actual length per 2-5/8" OD copper tubing
0.08	lb. per foot of 1/2" OD XDO supply connector actual length
0.26	lb. per foot of 7/8" OD XDO supply connector actual length
0.04	lb. per foot of 7/8" OD copper tubing XDO return connector actual length
0.07	lb. per foot of 1-1/8" OD copper tubing XDO return connector actual length
=	Amount of XD Coolant needed for ONE XDO/XDP system

Verify that the coolant volume of the XD system with the longest piping length is within the allowable limit. If the allowable limit is exceeded, exceeded, the XDP/XDC should be moved closer to the cooling modules. Another way to shorten the total pipe length is to reroute the pipe runs.

3.14 Liebert XDC DX R-407c Circuit Volume—Air Cooled Units

Weigh in the calculated charge based on **Tables 7**, **8** and **9**.

Table 7 Indoor unit refrigerant charge—R-407C

Model 60 Hz	Charge/Circuit lb. (kg)
XDC160	4.5 (2.0)

Table 8 Outdoor condenser charge—R-407C

Model	Charge / Circuit, lb (kg)
CDL830	182 (82.6)
CSL616	254 (115.2)
CSL415	182 (82.6)

Table 9 Liquid line charge - R-407C refrigerant per 100 ft (30 m) of Type “L” copper tube

O.D., inches	Liquid Line, lb (kg)	Hot Gas Line, lb (kg)
3/8	3.7 (1.7)	-
1/2	6.9 (3.1)	-
5/8	11.0 (5.0	2.2 (1.0)
3/4	15.7 (7.1)	3.1 (1.4)
7/8	23.0 (10.4)	4.5 (2.0)
1-1/8	39.3 (17.8)	7.8 (3.5)
1-3/8	59.8 (27.1	11.8 (5.4)
1-5/8	-	16.7 (7.6)

3.15 Chilled Water Piping

The XDP is offered only with a two-way chilled water control valve. Some applications may require the use of a pressure activated bypass valve, to prevent dead-heading of the chilled water pump. This bypass valve must be specified by the engineer responsible for design of the chilled water field piping system.

Chilled water connections to the XDP are near the bottom of the unit. Refer to the XDP user manual (SL-16641) for further information. Piping is routed downward from the unit to chilled water piping under the raised floor. Connections are made using standard practices for copper chilled water piping. Victaulic® connections may be used to simplify installation in existing facilities. Refer to **Table 15** for additional information.

3.16 Electrical

Make all wiring and electrical connections in accordance with local and national codes. Refer to equipment nameplate regarding wire size and circuit protection requirements. Refer to electrical schematic when making connections.

4.0 XD OVERHEAD COOLING MODULE—LIEBERT XDO

Standard Features XDO

- Micro Channel Heat Exchanger—The Liebert XDO unit includes two all-aluminum micro channel heat exchangers.
- Fan—Air is drawn in the sides of the unit through the heat exchangers, and is discharged by the fan to area below —XDO fan tray hinges down to allow access to replace or service all electrical components.
- Internal Mounting—The Liebert XDO unit is typically suspended from the overhead building structure by inserting field-supplied threaded rods into the internal mounting brackets.

Optional Features XDO

- External Mounting Brackets—The Liebert XDO unit can be suspended by external mounting brackets that are attached to the front and rear panels of the unit. The external mounting brackets are optional ship-loose items.
- Condensate Detection—The Liebert XDO unit is available with optional factory-installed condensate detection. The condensate detection has connection points (dry contacts) inside the unit.
- Lighting Fixture—Field installable lighting fixtures are available in two different voltages, 120V or 277V. Light Fixture maybe attached to the bottom of the light panel to the left and right of the fan. Each fixture consists of housing, reflector, ballast and diffuser. Fixtures are compatible with standard 48" fluorescent tubes. Lamps are not included.

Figure 22 XDO dimensional data

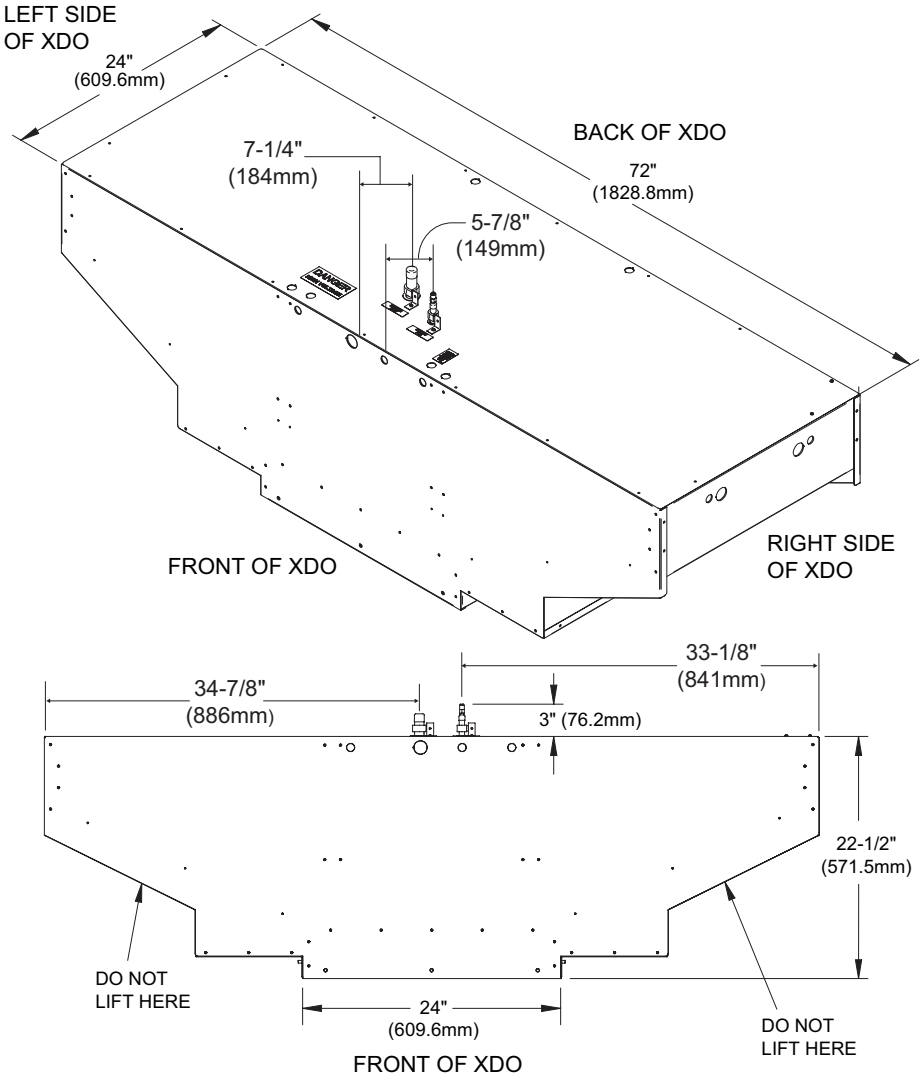


Figure 23 XDO16 internal mounting location

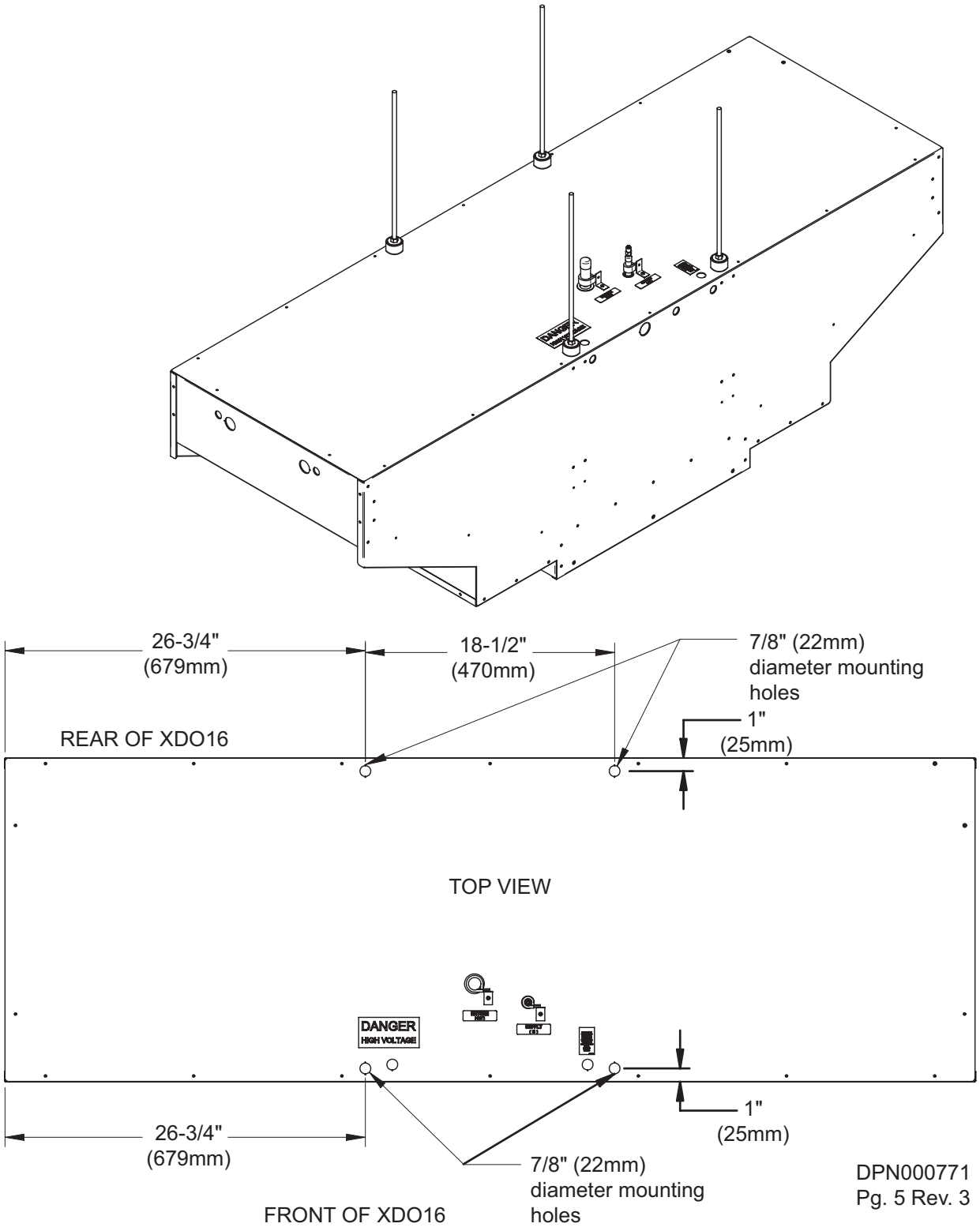
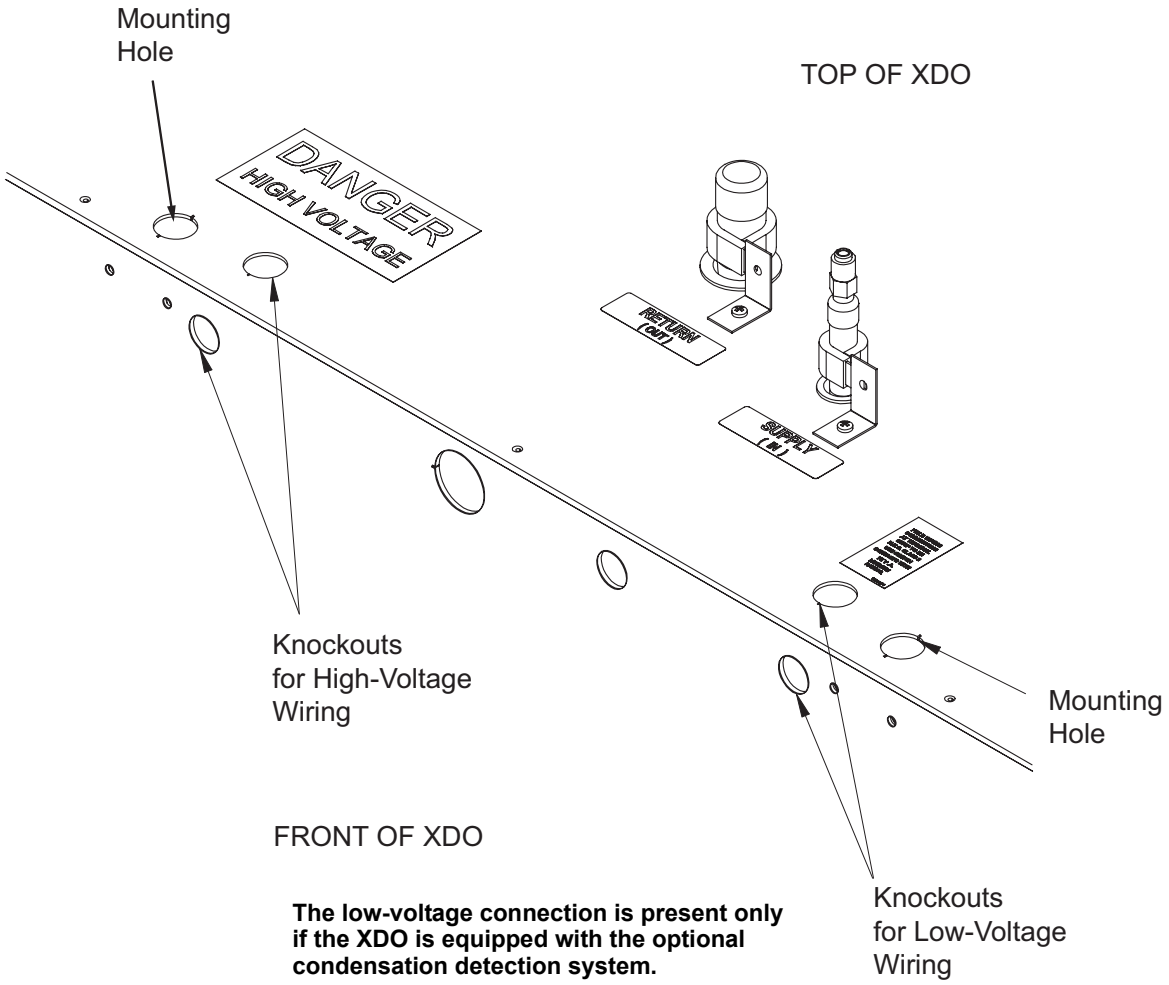


Figure 24 XDO top and front electrical access points



4.1 Liebert XD Vertical Top Cooler (XDV)

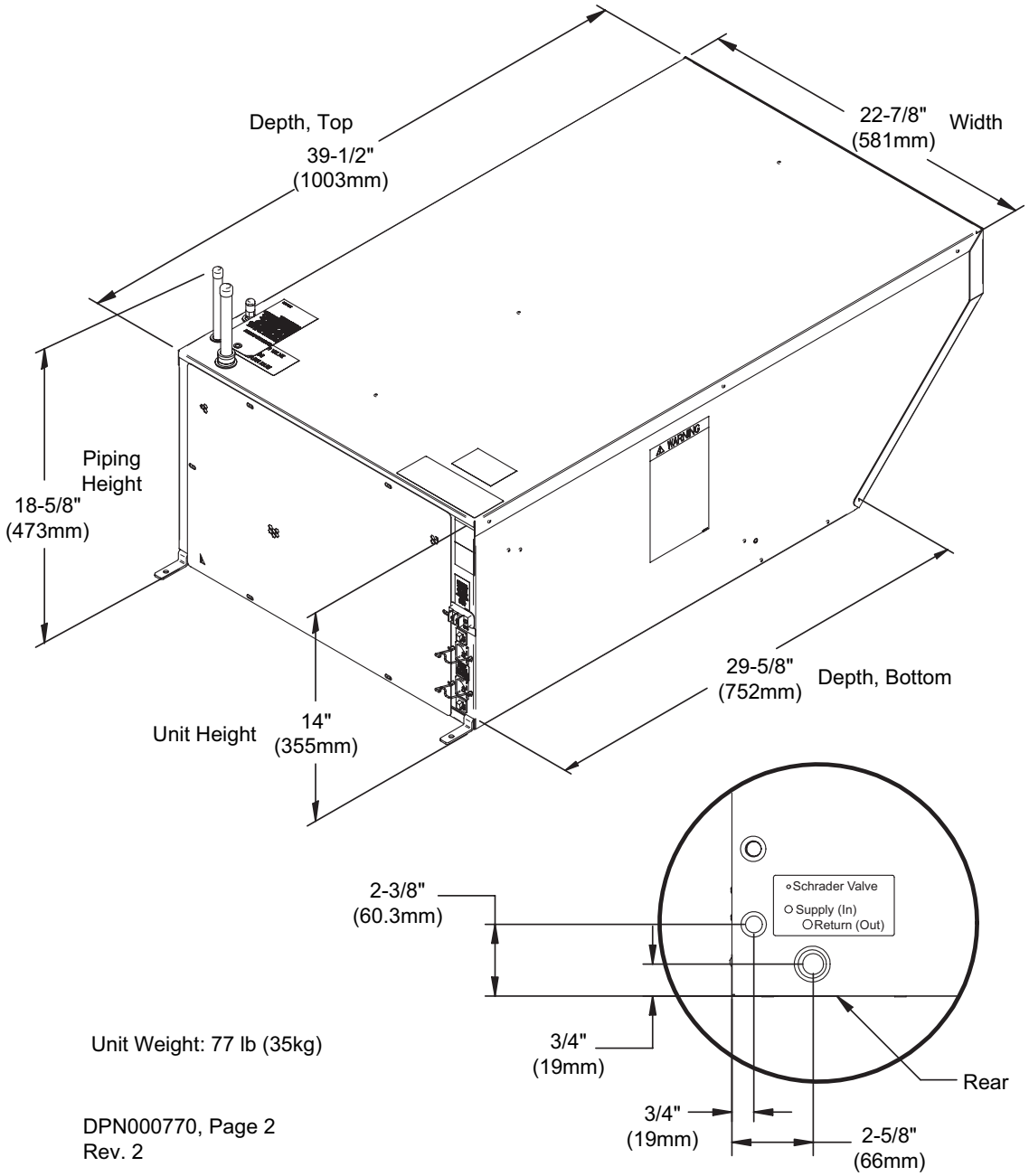
4.1.1 Standard Features Liebert XDV

- Micro Channel Heat Exchanger—The Liebert XDV unit includes one all-aluminum micro channel heat exchanger.
- Dual IEC Power Cords and Power Inlets—The Liebert XDV unit is supplied with two (2) detachable 10 ft (3m) power cords that attach to two (2) IEC power inlets in the rear of the unit. Each power cord has a NEMA 5-15P (IEC 320-C14) plug at the opposite end.
  This feature allows the unit to be powered by two separate power sources.
- Dual Air Inlets—The Liebert XDV unit can be configured to allow air to enter from the rear grille or the bottom of the unit.
- Dual Fans—Airflow is provided by two fans on the front of the unit. Dual switches—Controls on the front of the unit permit the use of one fan or both fans.
- Foundation Mounting—There are two 1/4-20 cage nuts located on the underside of unit which allow direct attachment to any Liebert Foundation cabinet, bolts provided with XDV unit.
- Mounting Clips for non-Liebert cabinets—The Liebert XDV unit is supplied with mounting clips that allow attachment to a non-Liebert cabinet (Some drilling maybe required).

4.1.2 Optional Features Liebert XDV

- Factory-Installed Flexible Piping (For use with prefabricated piping assemblies)—The Liebert XDV unit is available with two pre-attached and pre-charged flexible metal pipes for coolant supply and return. Each pre-attached flexible pipe has a threaded coupler that automatically shuts off, when disconnected.
- External Mounting Brackets—The XDV can be suspended from the overhead building structure. The external mounting brackets are ship-loose items.
- Field-Installed Flexible Piping (for use with prefabricated piping assemblies)—For XDV modules without the pre-attached flexible piping, a separate flexible piping kit can be used. The flexible pipes in the kit have threaded couplers that automatically shut off when disconnected.
- Condensate Detection—The Liebert XDV unit is available with factory-installed condensate detection. The condensate detection has connection points (dry contacts) at the external rear of the unit.

Figure 25 XDV dimensions



Unit Weight: 77 lb (35kg)

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Figure 26 XDV dimensions with factory-installed flex pipe

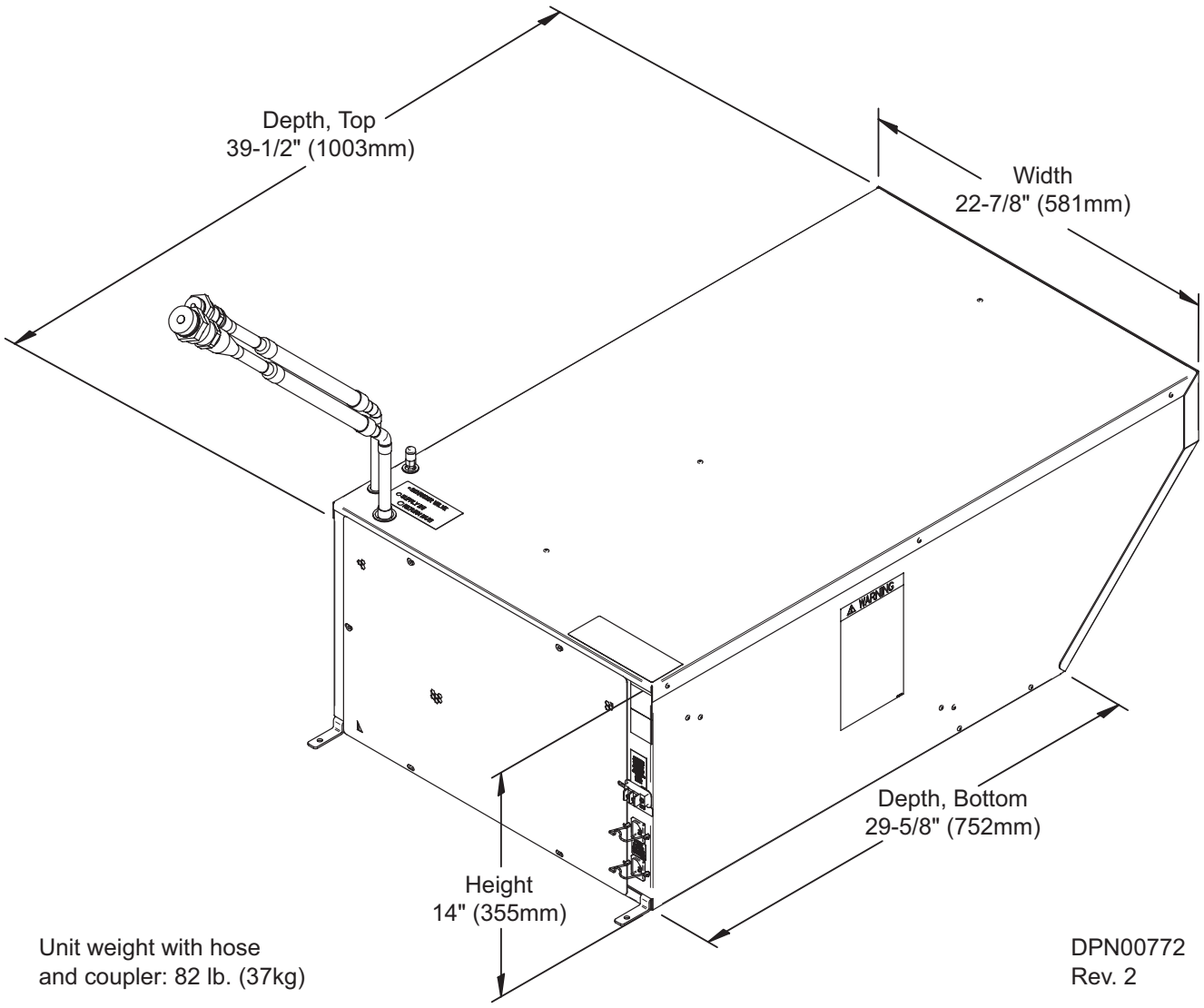

Figure 27 XDV electrical connections

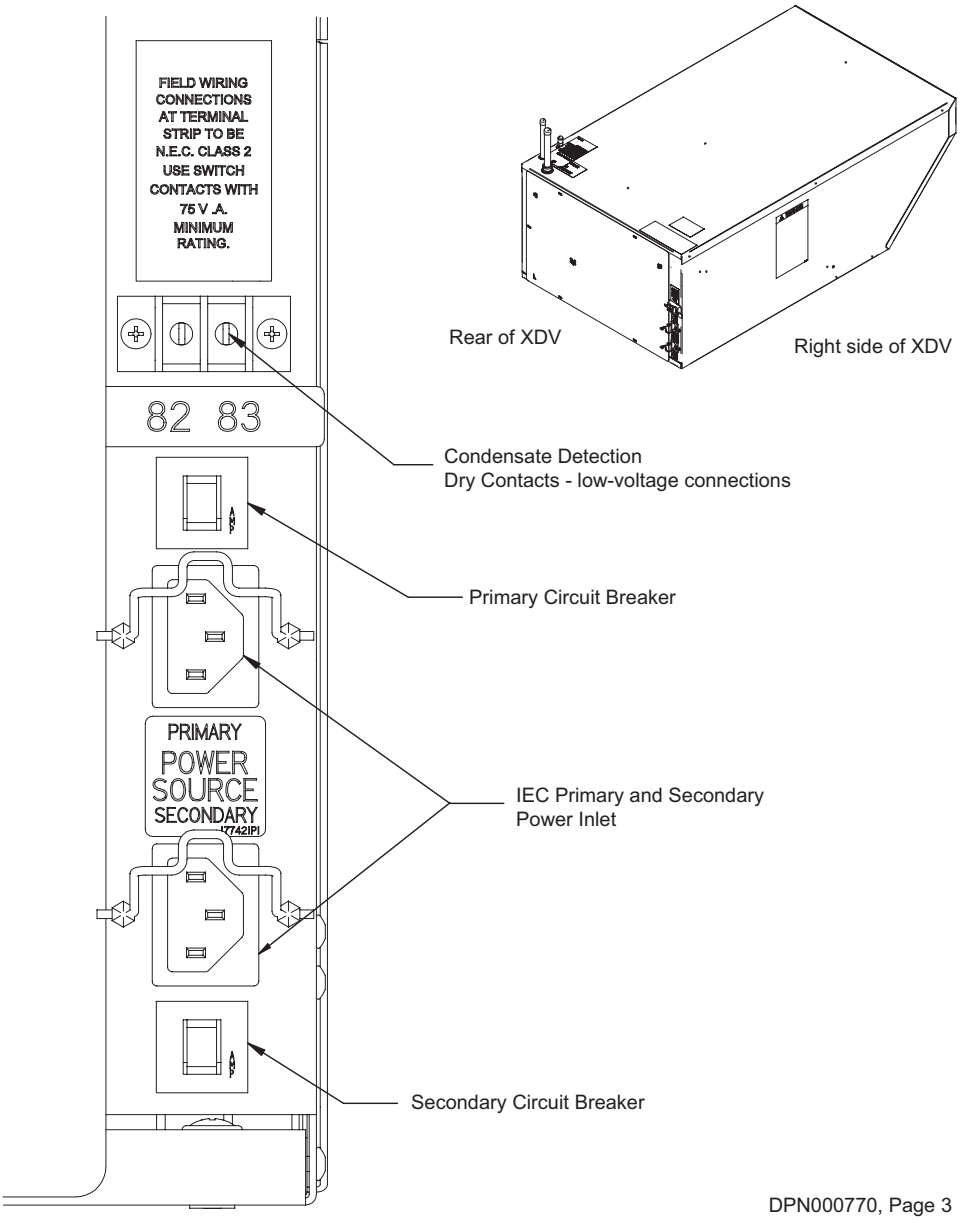

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Figure 28 Suspending single XDV from Unistruts

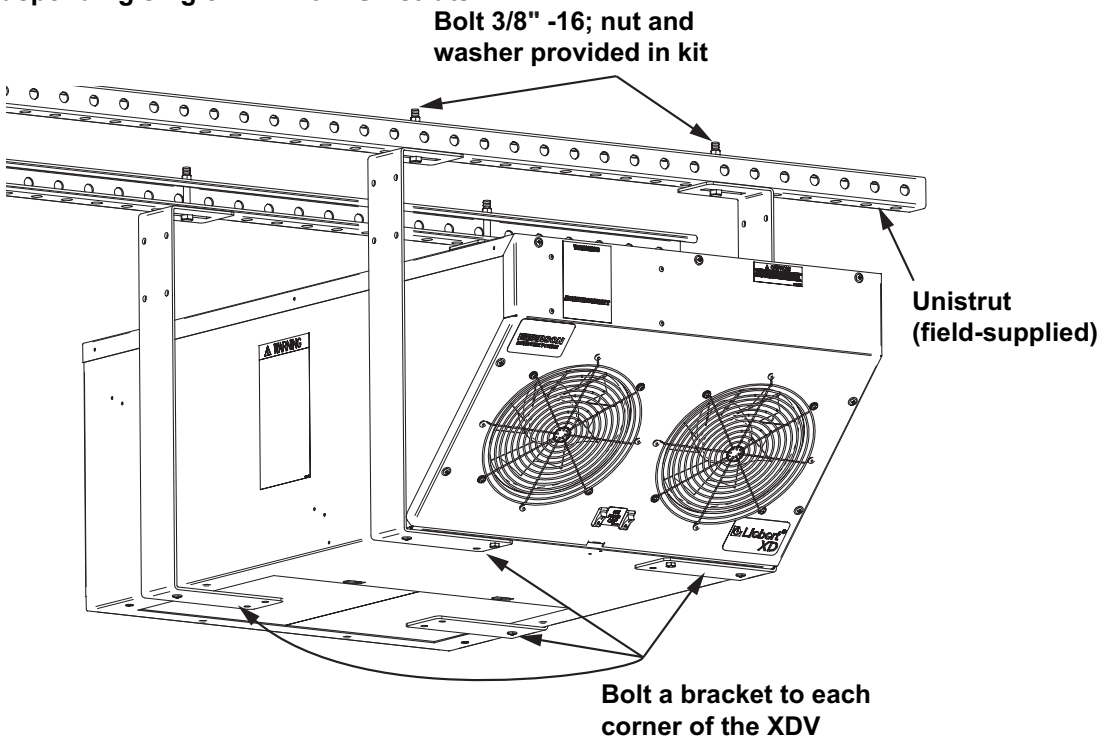


Figure 29 Suspending single XDV from the roof structure

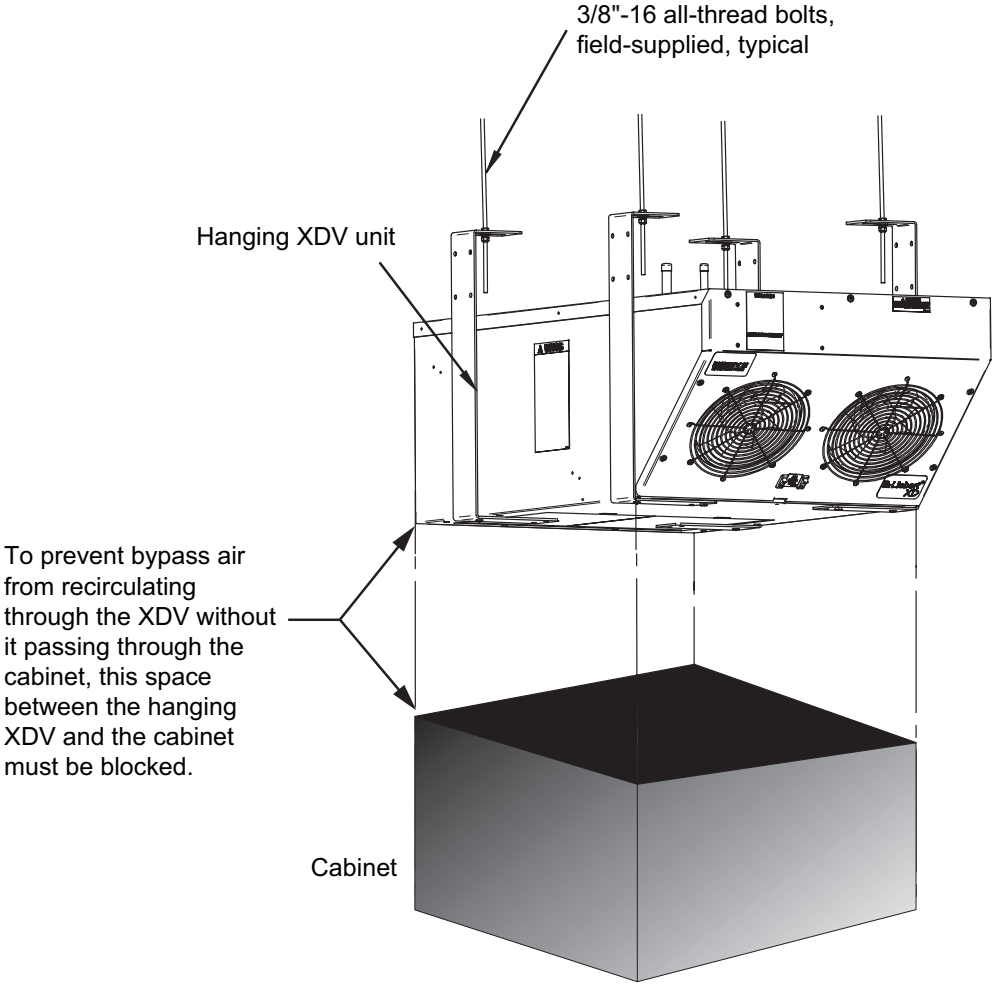
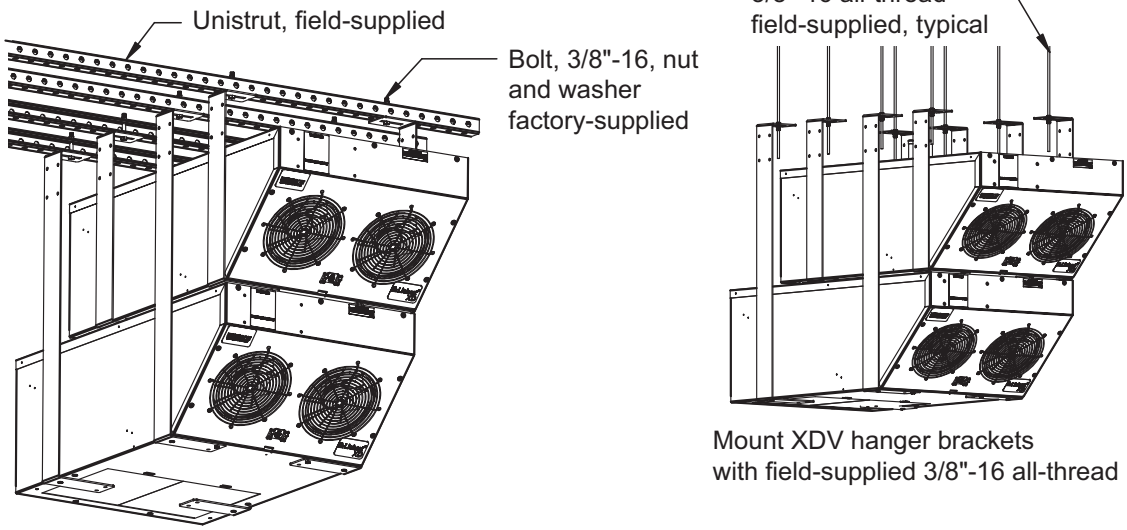


Figure 30 Alternative mounting methods—mounting multiple XDV units



Attach XDV hanger brackets to field-supplied Unistrut

Mount XDV hanger brackets with field-supplied 3/8"-16 all-thread

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Rev. 3, Pg. 7

4.2 Liebert XD Piping Dimensions and Features

Figure 31 Five-port prefabricated piping for XDV modules

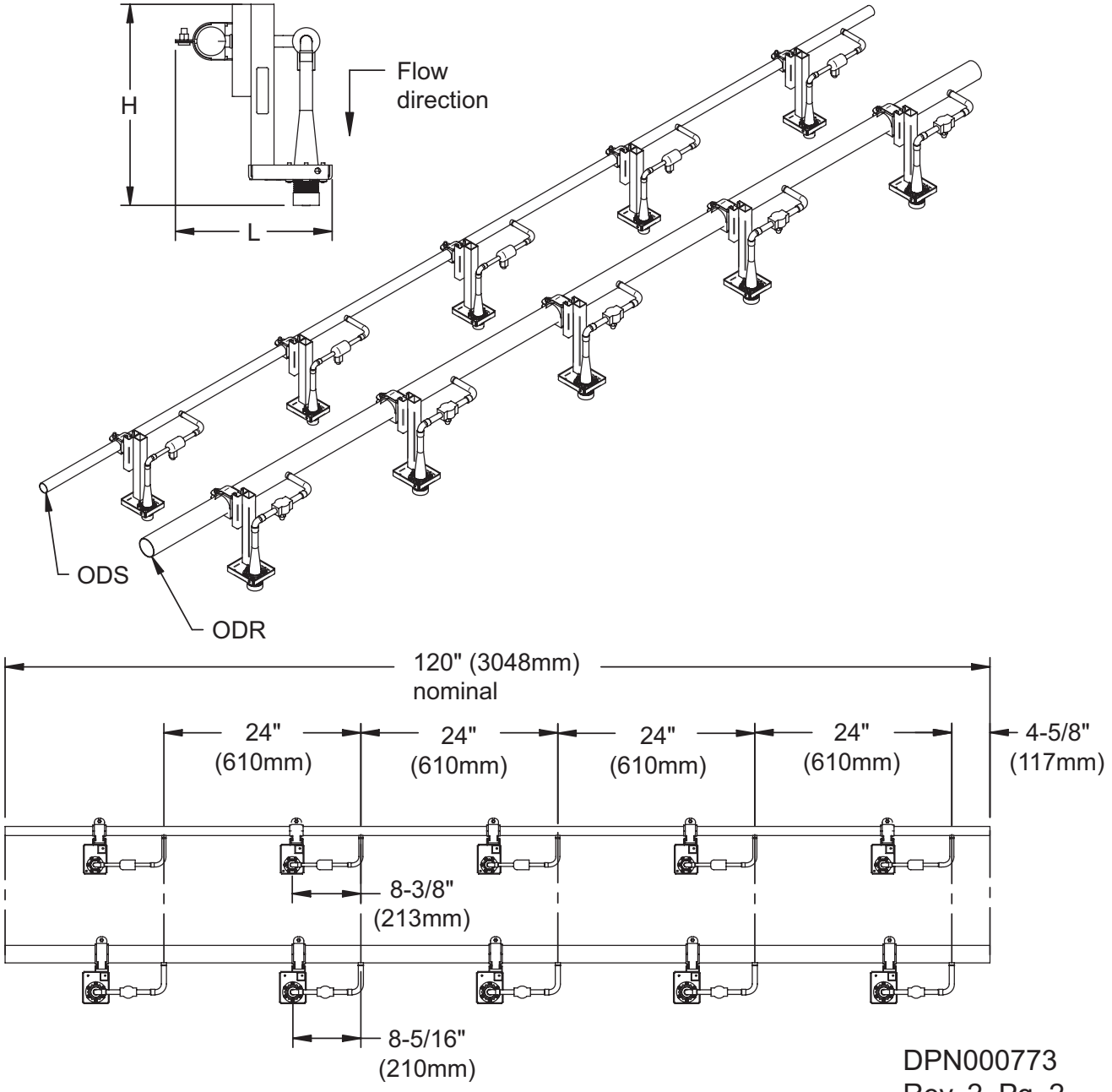


Table 10 Five-port prefabricated piping legend

Branch Piping		Standard Run	Long Run*
5 Port		181399G5#	183167G5#
Supply inch (mm)	Outside Diameter (ODS)	1-1/8	1-3/8
	Height (H)	8 (203)	8-1/2 (216)
	Length (L)	6-3/4 (171)	7 (178)
Return inch (mm)	Outside Diameter (ODR)	2-1/8	2-5/8
	Height (H)	10 (254)	10 (254)
	Length (L)	8-1/8 (207)	8-1/2 (216)

* Pipe runs that are greater than 60 equivalent feet

Suffix indicates the number of complete sets of prefabricated assemblies can be either 2 or 1. Completed assemblies consist of # of supply, # of return.

Figure 32 Two-port prefabricated piping for XDV modules

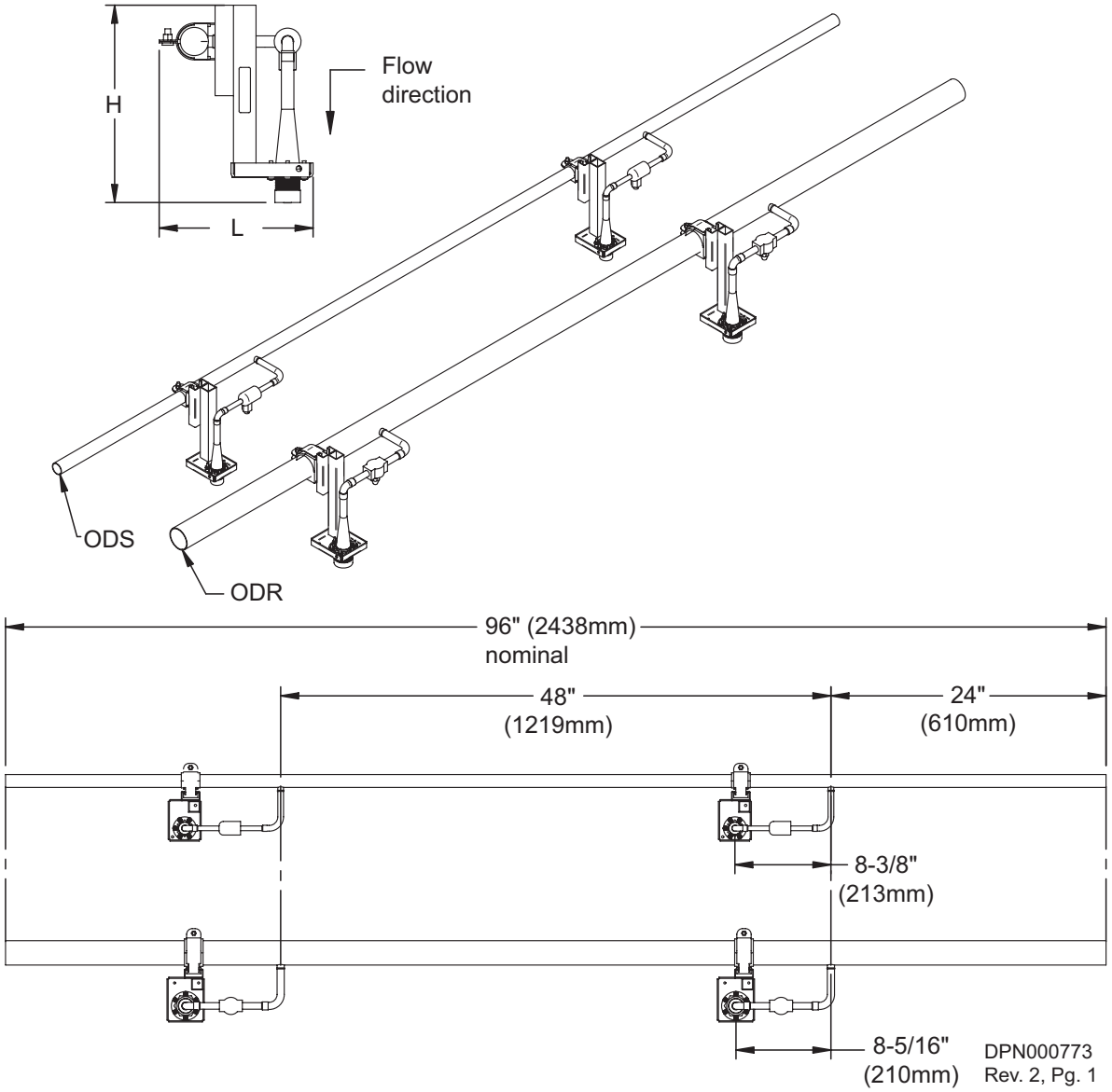


Table 11 Two-port prefabricated piping legend

Branch Piping		Standard Run	Long Run*
2 Port		181399G2#	183167G2#
Supply inch (mm)	Outside Diameter (ODS)	1-1/8	1-3/8
	Height (H)	8 (203)	8-1/2 (216)
	Length (L)	6-3/4 (171)	7 (178)
Return inch (mm)	Outside Diameter (ODR)	2-1/8	2-5/8
	Height (H)	10 (254)	10 (254)
	Length (L)	8-1/8 (207)	8-1/2 (216)

* Pipe runs that are greater than 60 equivalent feet

Suffix indicates the number of complete sets of prefabricated assemblies can be either 2 or 1. Completed assemblies consist of # of supply, # of return.

4.3 Liebert XDP Standard Features

- Heat Exchanger—Brazed plate design with interwoven circuiting constructed of stainless steel plates, copper brazed.
- Pumps—Centrifugal type, end suction, canned rotor design.
- Standard Control Processor—The standard control system is microprocessor-based with an external LCD numerical display to allow observation of specified adjustable functions. Normal operating conditions are indicated on the LCD panel, which is mounted either on the unit or on the wall, depending on application details (see user manual, SL-16641). The control system also monitors unit operation and activates an alarm when any of the specified factory preset conditions are exceeded.
- Cabinet and Frame—Custom powder painted steel panels. A hinged control access panel opens to a second front panel, which is a protected enclosure for all high voltage components. Frame is constructed of 14 gauge hell-arc welded tubular steel and painted using an auto-deposition coating system.

Figure 33 XDP dimensions, access points and external features

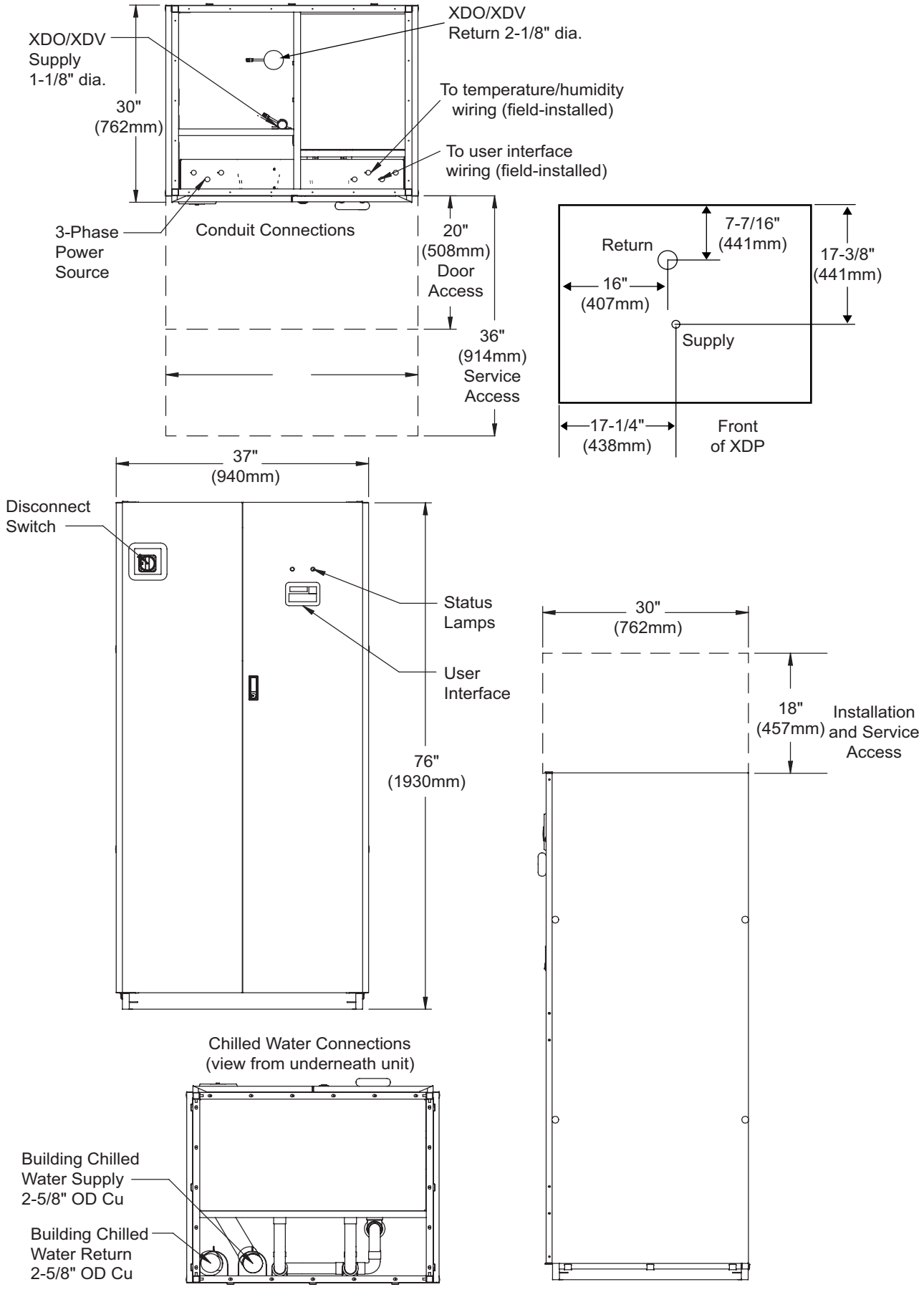


Figure 34 Front view of XDP and electrical enclosure

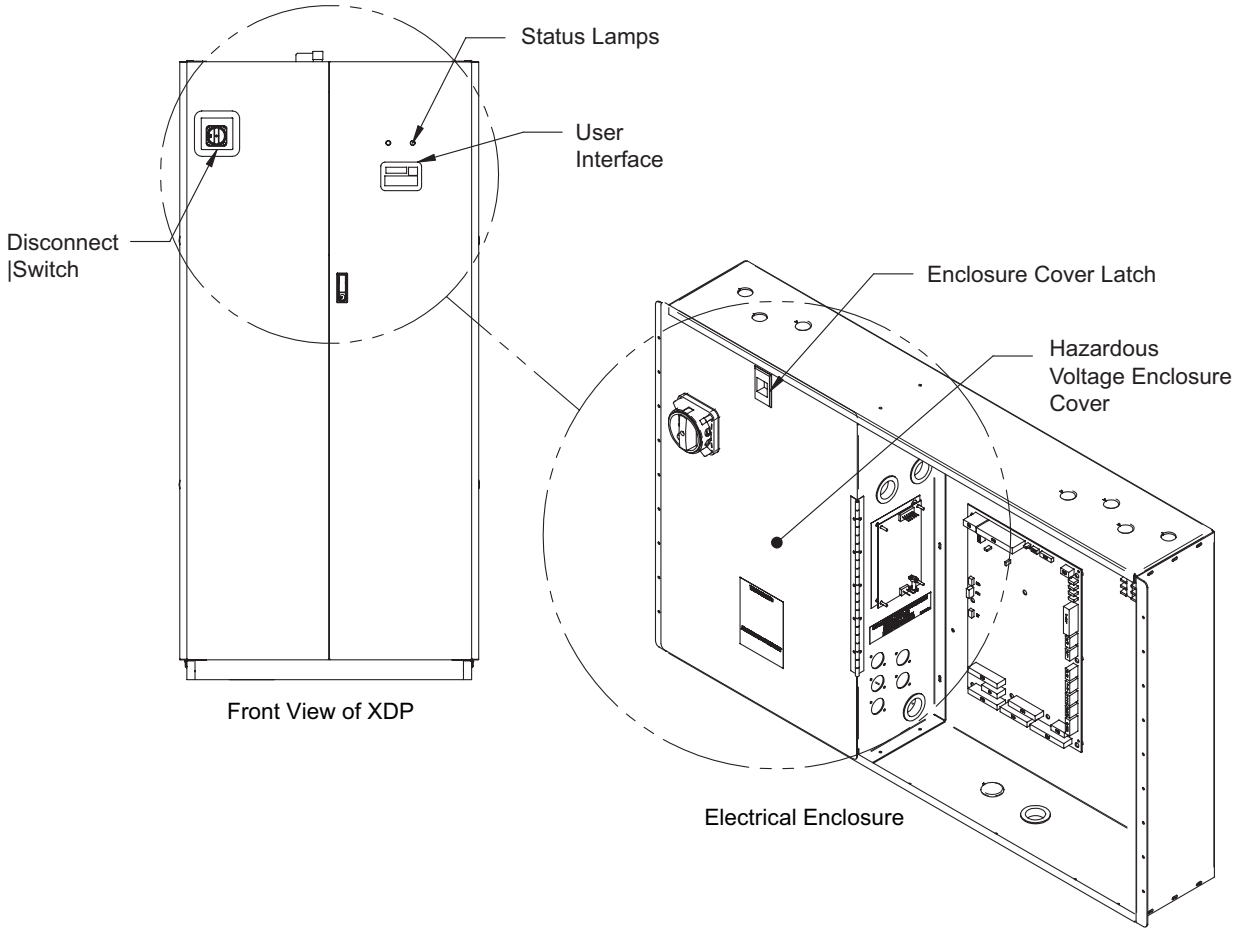


Figure 35 XDP electrical enclosure knockout locations for field wiring

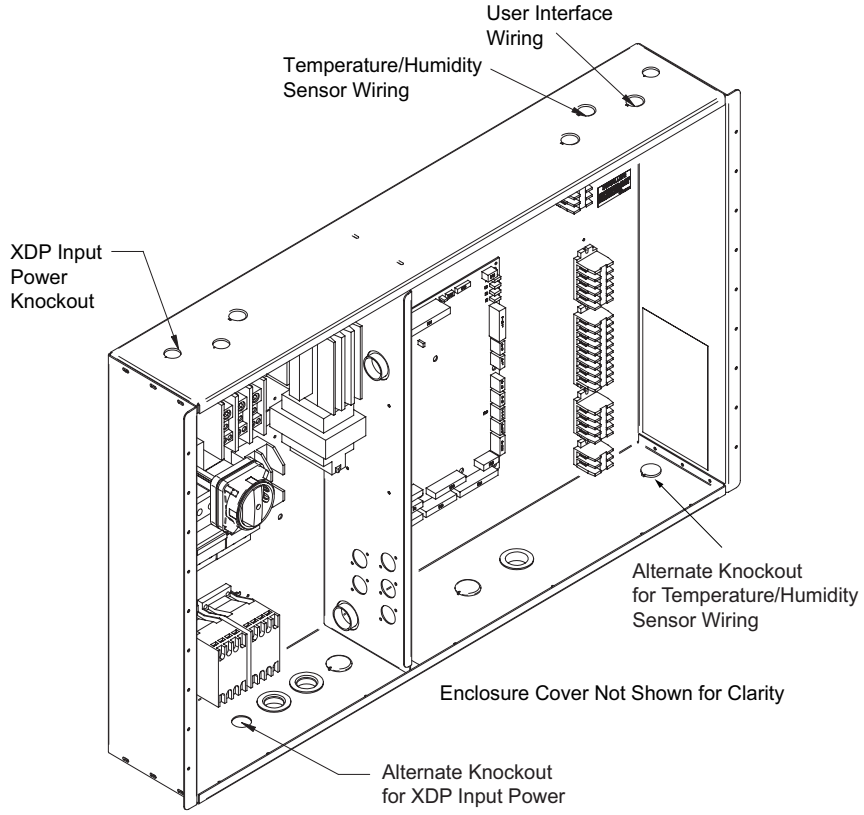
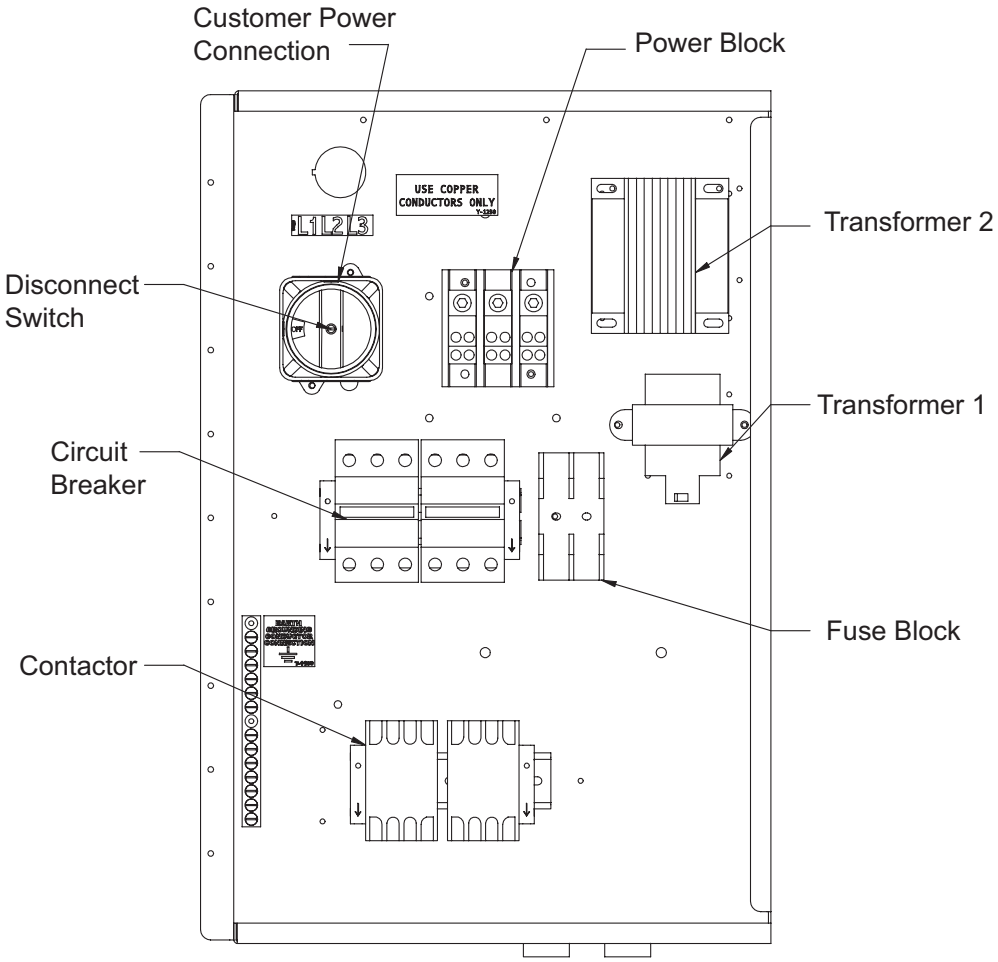

User Interface Wiring
Temperature/Humidity Sensor Wiring
XDP Input Power Knockout
Alternate Knockout for Temperature/Humidity Sensor Wiring
Enclosure Cover Not Shown for Clarity
Alternate Knockout for XDP Input Power

Figure 36 XDP high voltage connections



4.4 Liebert XDC Standard Features

- Compressors—Scroll with a suction gas cooled motor, vibration isolators, thermal overloads, manual reset high-pressure switch and pump down low-pressure switch.
- Refrigeration System—Dual refrigeration circuits each including liquid line filter dryers, refrigerant sight glass with moisture indicator, electronic control valve, adjustable externally equalized expansion valves and liquid line solenoid valves.
- Heat Exchanger—Brazed plate design with interwoven circuiting constructed of stainless steel plates, copper brazed. PUMPS Centrifugal type, end suction, canned rotor design.
- Standard Control Processor—The standard control system is microprocessor-based with an external LCD numerical display to allow observation of specified adjustable functions. Normal operating conditions are indicated on the LCD panel, which is mounted either on the unit or on the wall, depending on application details (see user manual, SL-16671). The control system also monitors unit operation and activates an alarm when any of the specified factory preset conditions are exceeded.
- Cabinet and Frame—Custom powder painted steel panels. A hinged control access panel opens to a second front panel, which is a protected enclosure for all high voltage components. Frame is constructed of 14 gauge heliarc welded tubular steel and painted using an auto-deposition coating system.

Figure 37 XDC dimensional data

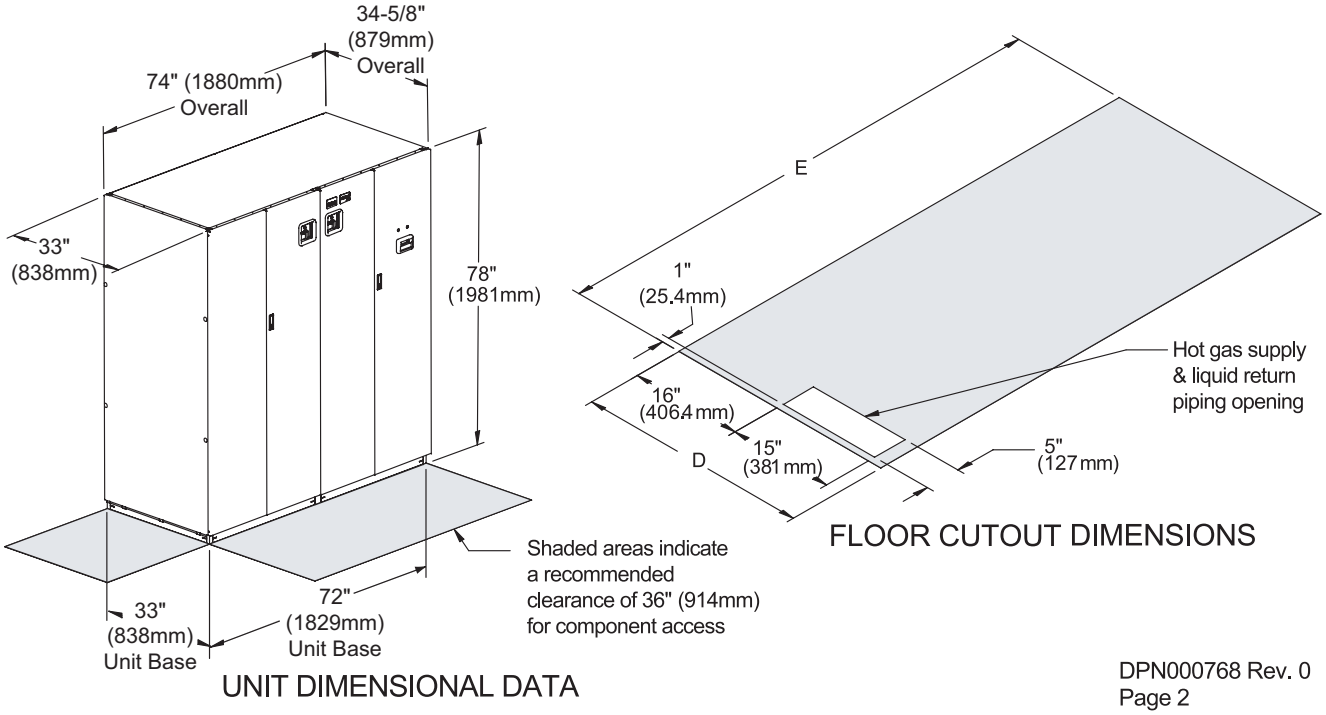


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Figure 38 XDC piping locations

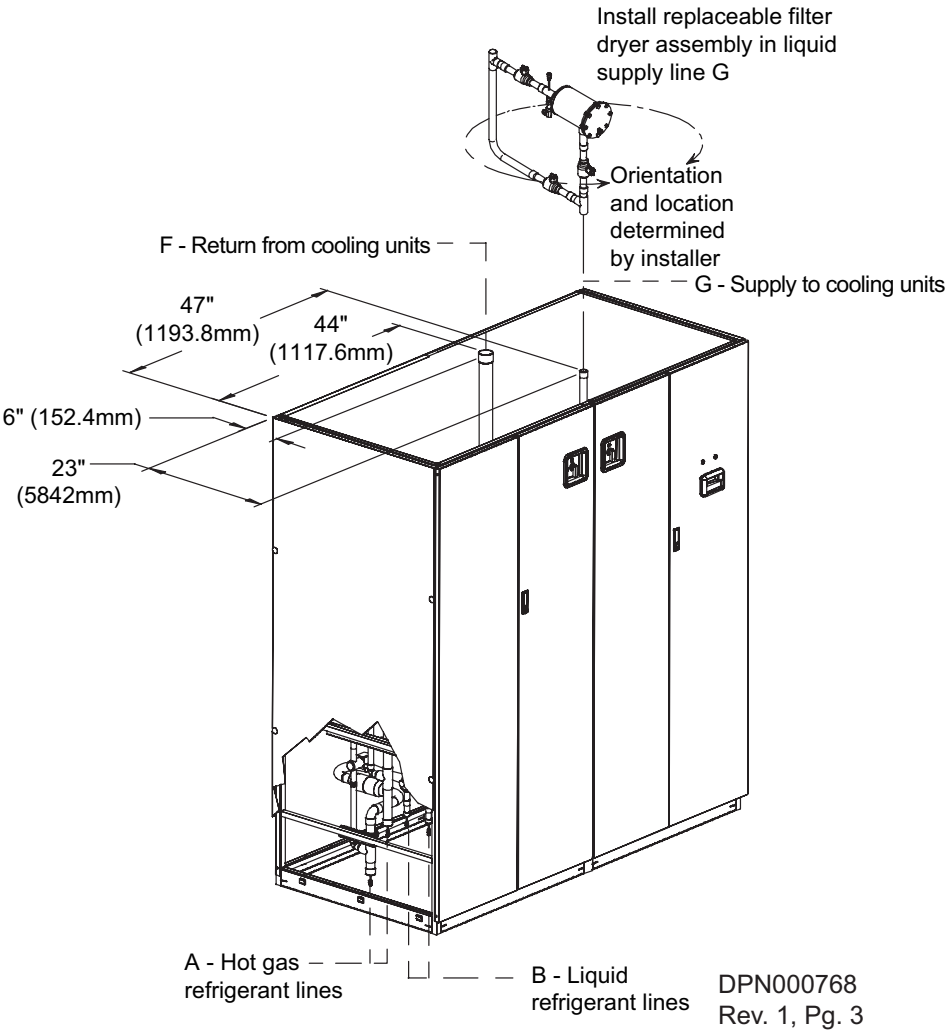
Install replaceable filter dryer assembly in liquid supply line G
Orientation and location determined by installer
F - Return from cooling units
G - Supply to cooling units
47" (1193.8mm)
44" (1117.6mm)
6" (152.4mm)
23" (5842mm)
A - Hot gas refrigerant lines
B - Liquid refrigerant lines
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Figure 39 Front view of XDC and electrical enclosures

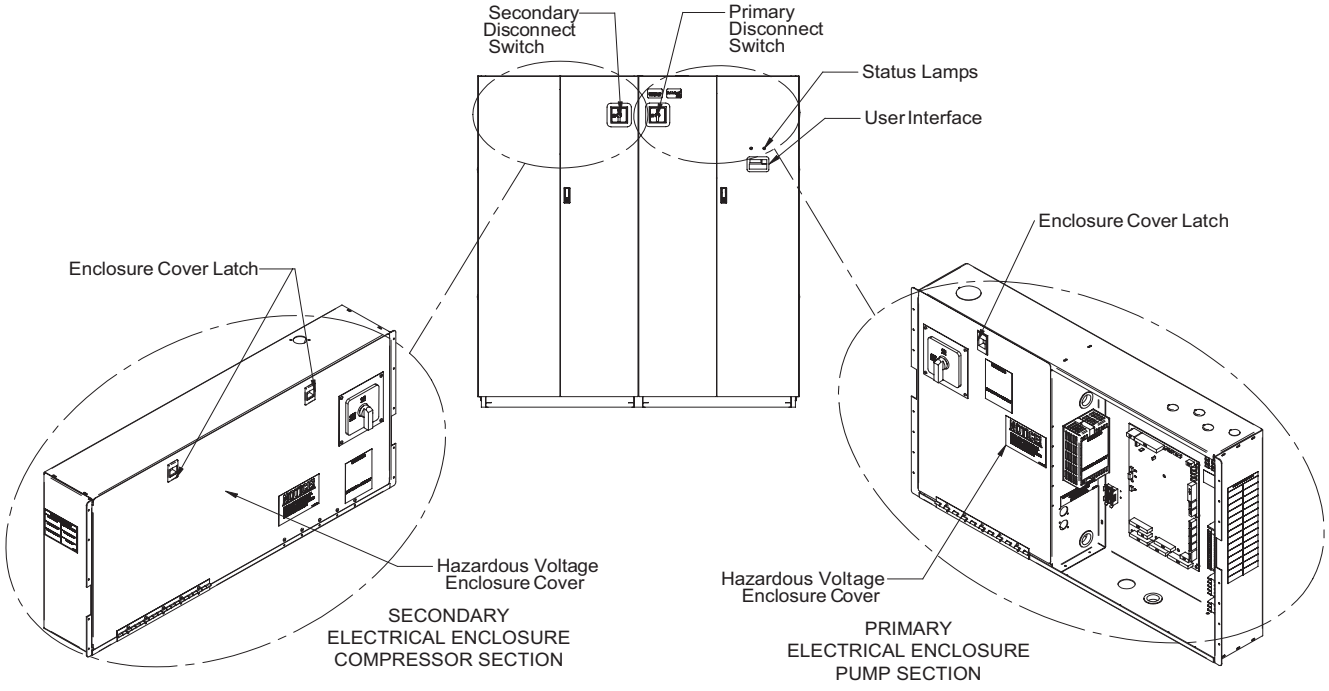


Figure 40 XDC electrical enclosure knockout locations for field wiring

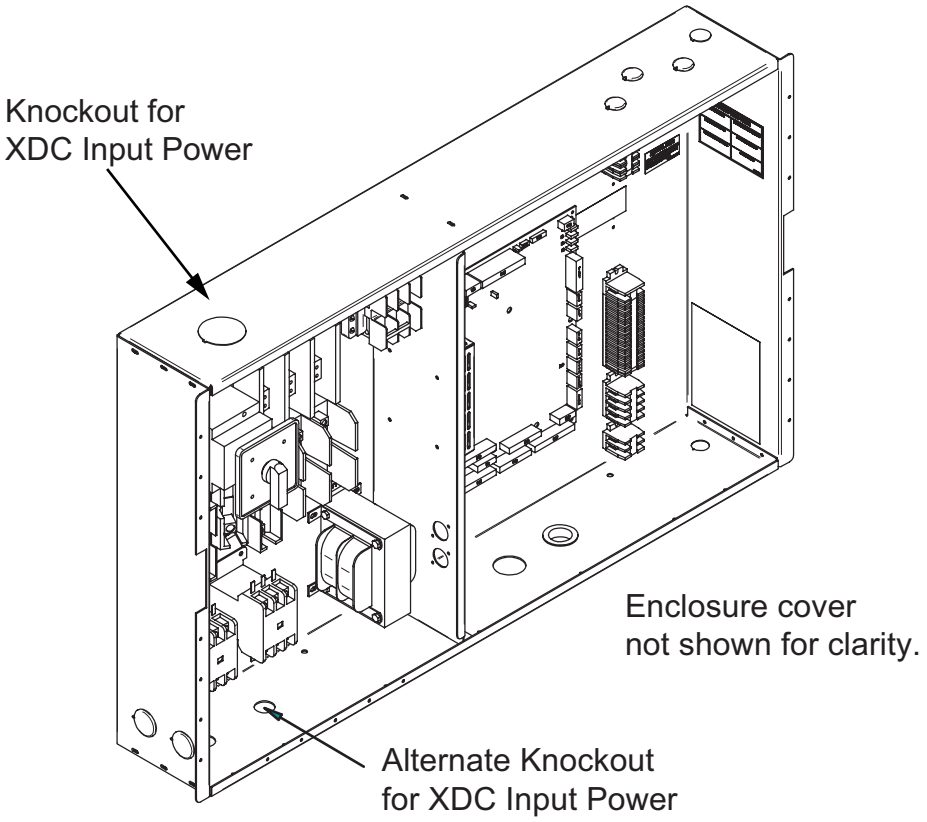


Figure 41 XDC high voltage connections—primary disconnect switch

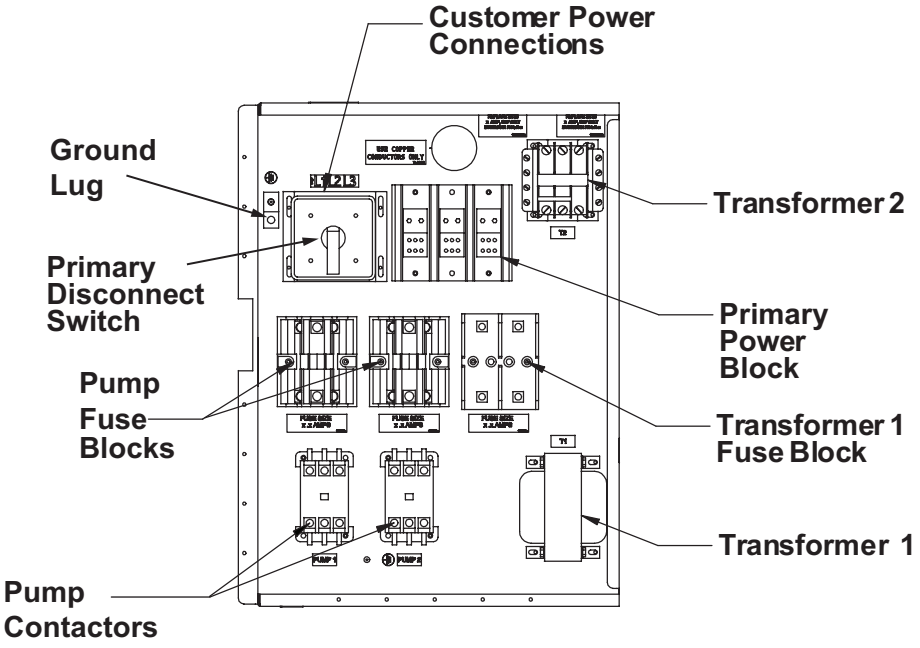


Figure 42 XDC high voltage connections—secondary disconnect switch

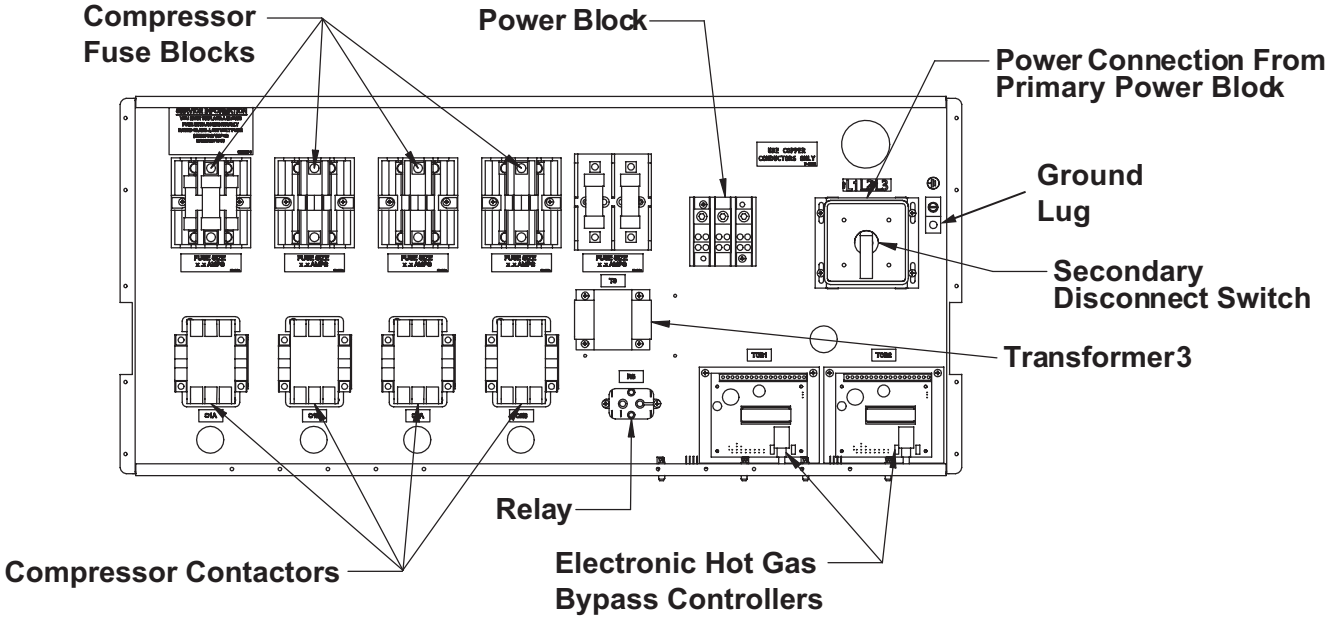


Figure 43 XDC heat rejection electrical connection points

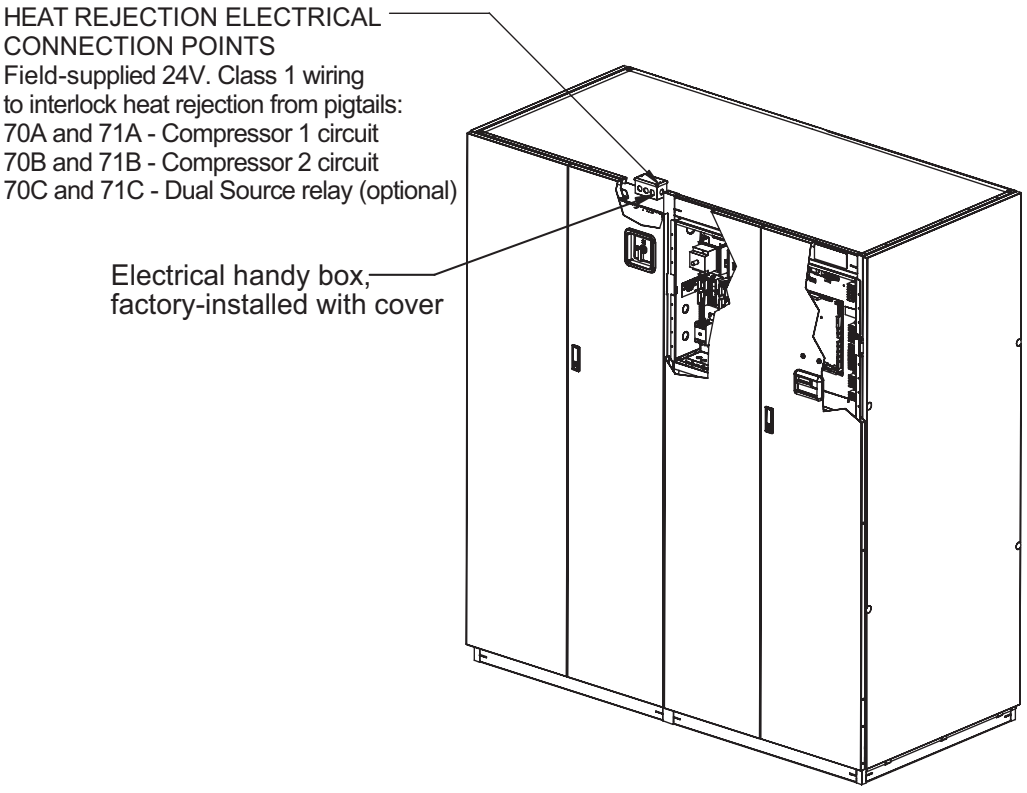

HEAT REJECTION ELECTRICAL
CONNECTION POINTS
Field-supplied 24V. Class 1 wiring
to interlock heat rejection from pigtails:
70A and 71A - Compressor 1 circuit
70B and 71B - Compressor 2 circuit
70C and 71C - Dual Source relay (optional)
Electrical handy box,
factory-installed with cover

Figure 44 XDC electrical enclosure knockout locations for ELV

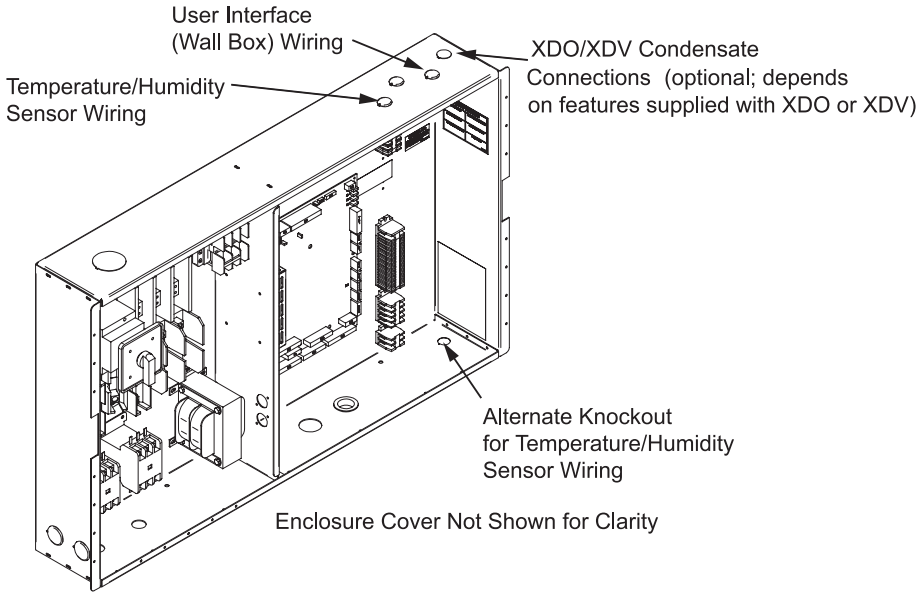
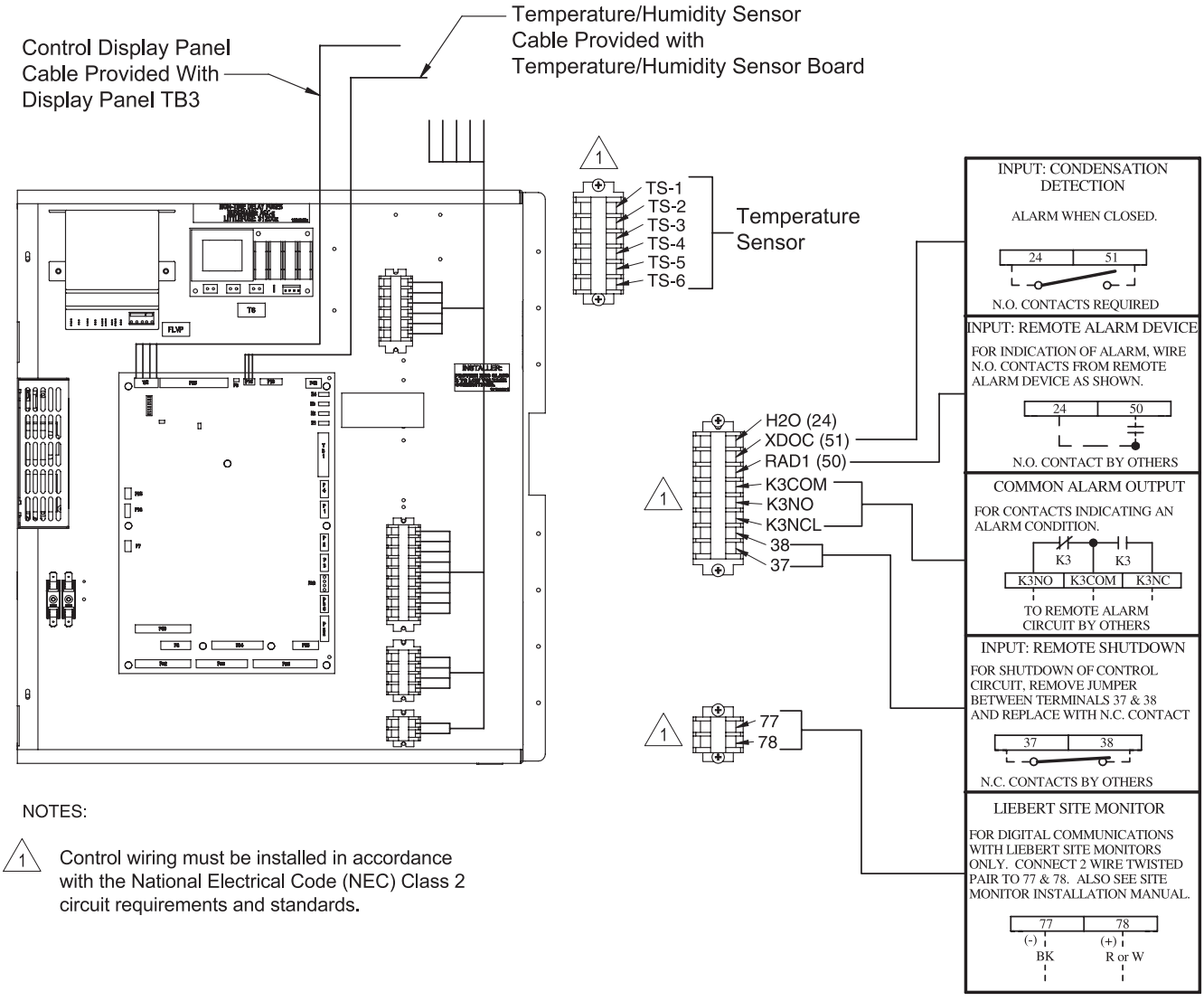


Figure 45 XDC ELV field connections points



NOTES:

1. Control wiring must be installed in accordance with the National Electrical Code (NEC) Class 2 circuit requirements and standards.

5.0 SPECIFICATIONS

Table 12 Liebert XDO specifications

Models	XDO16BK--0, XDO16DK--0 (60Hz)	XDO16BT--0, XDO16DT--0 (60Hz)	XDO16BT--0, XDO16DT--0 (50Hz)
Cooling Capacity, nominal	16kW / 4.6 Tons	16kW / 4.6 Tons	14kW / 3.98 Tons
Conditions	55ºF Entering Coolant Temperature, 85ºF Entering Air Temperature, 50ºF or lower dew point		
Electrical Requirements			
Input Voltage	1ph-60Hz-120V	1ph-60Hz-230V	1ph-50 Hz-230V
Input Power Connections	Terminal blocks provided on unit		
Full Load Amps	2.7A @ 120V	1.44A @230 V	
Wire Size Amps	3.4	2.05	
Overcurrent Protection Device	15		
Power consumption, nominal	374 Watts		
Power, optional lighting fixture	0.9A per 120V light fixture; 0.4A per 277V light fixture		None
Dimensions, inches (mm)			
Width	72 (1828.8)		
Depth	24 (69.6)		
Height	22-1/2 (571.5) not including electrical and piping access		
Weight, lb (kg)			
Unit only	150 (68)		
Shipping weight	238 (108)	296 (134)	
Installed, with coolant, without options	155 (70)		
Number of Fans	1	1	1
Airflow, Nominal, ft^3/ min (m^3/ hr)	2700 (4587)		2250 (3822)
Audible Noise	85 dBa sound power		83 dBa sound power
Pipe Connections			
XD Coolant Supply from XDP/XDC	1/2" OD, Cu		
XD Coolant Return to XDP/XDC	7/8" OD, Cu		
Serviceable Parts	Fan and electrical components		
Exterior Finish – Bottom, Sides, Front and Rear	Black, matte finish, heat-fused powder coat		
Exterior Finish - Top	Hot-dipped galvanized steel		
Condensate sensing (factory-installed)	Dry contact 24VAC - 1A maximum		
Agency			
Safety	CSA	CSA (60Hz), CE pending (50Hz)	

Options	
Lighting fixtures (ship loose)	2 XDOs per lighting unit; 120V or 277V; 4' standard fluorescent tubes (not provided)

Table 13 Liebert XDC specifications

Parameter	60Hz Models	50Hz Models
Cooling Capacity, Nominal	46 tons / 160kW with 125ºF (51.6ºC) condensing temperature and 50ºF (10ºC) evaporating temperature	37 tons / 130kW with 125ºF (51.6ºC) condensing temperature and 50ºF (10ºC) evaporating temperature
Electrical Requirements		
Input	460V model: 3 phase, 60Hz	380/420V models: 3phase, 50Hz
Full Load Amps	79A	
Minimum supply wire sizing ampacity	84A	
Maximum fuse or circuit breaker size	100A	
Dimensions, inches (mm)		
Height – Unit only	78 (1981)	
Height – As shipped	83 (2108)	
Width	74 (1879)	
Depth	34 (863)	
Weight, lb (kg)		
Unit only	2000 (907)	
Shipping weight	2050 (930)	
Installed, with R-134a	2200 (998)	
Pipe Connections		
XD Coolant supply to XDO or XDV	1-1/8" OD, Cu	
XD Coolant return from XDO or XDV	2-1/8" OD, Cu	
Liquid Line (DX circuit)	7/8" OD, Cu	
Hot Gas Line (DX circuit)	1-3/8" OD, Cu	
Number of XDOs Connected	Maximum,10; Minimum, 4	
Number of XDVs Connected	Maximum, 20; Minimum, 8	
Cabinet Exterior Finish	Black, matte finish, heat-fused powder coat	

Table 14 Liebert XDV specifications

Number of models	8, based on input voltage, optional condensate sensing and flex hose option	
Cooling capacity, nominal	8 kW / 2.2 Tons	6.5 kW / 1.85 Tons
	Each capacity is based on 55ºF Entering Coolant Temperature, 92ºF Entering Air Temperature, 50ºF or lower dew point, rear inlet.	
Electrical requirements		
Input	120V model: 1ph-60 Hz	230V model: 1ph-50 Hz
Input power connections	120V model: 2 power connections	230V model: 2 power connections
Full Load Amps	120V model: 2.0 A	230V model: 1.0 A
Power consumption, nominal	200 Watts	200 Watts
Dimensions, inches (mm)		
Height – unit only	14-1/8 (359) not including pipe connections	
Height – including pipe connections	18-7/8 (479)	
Width	23-1/2 (597)	
Depth – Top	39-3/4 (1010)	
Depth – Bottom	29-3/4 (756)	
Weight, lb (kg)		
Unit only	77 (35)	
Shipping weight	125 (57)	136 (62)
Installed, with coolant	79 (36)	
Number of fans	2	
Airflow, nominal, ft^3/min (m^3/hr)	1000 (1699) with rear inlet. Bottom inlet airflow may be less, depending on restrictions inside cabinet.	833 (1415) with rear inlet. Bottom inlet airflow may be less, depending on restrictions inside cabinet.
Audible noise	78 dBa sound power	
Pipe connections		
XD Coolant supply from XDP/XDChiller	1/2" OD, Cu, (optional 1/2" threaded coupler flex hose)	
XD Coolant return to XDP/XDChiller	5/8" OD, Cu, (optional 3/4" threaded coupler flex hose)	
Serviceable parts	Fans and electrical components	
Cabinet exterior finish	Black, matte finish, heat-fused powder coat	
Options		
Condensate sensing (factory-installed)	Dry contact outgoing signal	
Agency		
Safety	CSA	None

Table 15 Liebert XDP specifications

Number of Models	4, based on input voltage and pump redundancy
Cooling Capacity, Nominal	160 kW / 46 Tons, 60Hz 140 kW / 40 Tons, 50Hz Each capacity is based on 45ºF (7ºC) entering water temperature and 140gpm (530lpm) water flow rate. Capacity is reduced when glycol mixtures are used in place of 100% water.
Electrical Requirements	
Input	208V model: 3-phase, 60Hz 460V model: 3 phase, 60Hz 380/420V model: 50Hz
Full Load Amps	208V model: 4A 460V model: 2.1A 380/420V model: 3A
Dimensions, inches (mm)	
Height – Unit only	76 (1930) does not include pipe connections
Height – As shipped	83 (2108)
Width	37 (940)
Depth	30 (762)
Weight, lb (kg)	
Unit only	855 (388)
Shipping weight	960 (435)
Installed, with coolant and chilled water	1025 (465)
Pipe Connections	
XD Coolant supply to XDO or XDV	1-1/8" OD, Cu
XD Coolant return from XDO or XDV	2-1/8" OD, Cu
Chilled water supply and return	2-5/8" OD, Cu
Control valve	2-way, 2" nominal
Pressure Drop – Chilled Water Side	20 PSIG, with 140 gpm (530lpm) water flow rate, control valve fully open
Temperature Rise – Chilled Water Side, F (C)	8.0° (4.4°) with rated flow
Number of XDOs Connected	Maximum 10; minimum 2
Number of XDVs Connected	Maximum 20; minimum 4
Cabinet Exterior Finish	Black, matte finish, heat-fused powder coat

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SL-16655 (02/06) Rev. 1

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